

# Subterranea

April 2012 Issue 29

ISSN 1741-8917

**In This  
Issue...**

**Sussex Auxiliary Units**

**Mining in the Harz mountains**

**Visit to Titan silos in USA**

**Bourne Park tunnel, Kent**

Subterranea Britannica



[www.subbrit.org.uk](http://www.subbrit.org.uk)

Subterranea Britannica is a society devoted to the study of man-made and man-used underground structures and the archaeology of the Cold War. The society is open to all and its membership includes all walks of life. Members are invited to contribute to this magazine even if this just means sending very welcome snippets from newspapers and magazines.

Editor: Nick Catford 13 Highcroft Cottages London Road Swanley Kent BR8 8DB  
e-mail editor@subbrit.org.uk

## Contents

### Features

From the Chairman _____	1	Visits to Tessin and Prora, Germany _____	20
Meet our Treasurer – Tony Radstone _____	2	Is there or was there a Cold War buffer depot near you? __	27
Dates for Your Diary _____	2	Europe's largest underground oil power-plant _____	28
<b>News</b>		Bourne Park Tunnel, and HMG <i>Boche-Buster</i> _____	31
Archaeology _____	3	Sussex WWII Auxiliary Units – Revisited _____	41
Health & Safety _____	4	Underground Disappointment at Hughenden Manor __	45
Mines & Mining _____	4	Glückauf! : Harz Mining and Mining Museums, Germany	46
Military _____	5	Remains of Manchester Picc-Vic tube system unearthed	54
Miscellaneous _____	10	Carshalton Air-Raid Shelter, Surrey _____	56
Books and Publications _____	14	Chalk Mining near Blackheath Hill _____	58
Tunnels and Tunnelling _____	15	Titan Tours _____	65
		Latest News from the Wartling Bunker Project _____	74
		Deep Underground in West Sussex and Norway _____	76

**Front cover photo:** No 3 turbine hall at the Stenungsund power station in Sweden. The two 280MW generators have been converted to run on light diesel fuel and are still in the Swedish national reserve ready to start up in cold weather when there is greater demand. Photo Nick Catford

**Back page upper:** The semi-automated feed of ore from hoppers into buckets on an overhead cableway at the Buchenberg iron mine in the Harz Mountains in Germany. Photo Ken Geddes

**Back page lower:** The former Volksmarine command bunker at Tessin in Germany. The heart of the bunker is the dispatch room. From here, key functionality would be controlled such as the ventilation and electrical systems.  
Photo Nick Catford

### Officers

Honorary President: Prof. C. T. Shaw  
Chairman: Martin Dixon  
Vice Chairman: Linda Dixon  
Secretary: Roger Starling  
Membership: Nick Catford  
Treasurer: Tony Radstone

### Committee

Mark Russell  
Richard Seabrook: Webmaster  
Andrew Smith : PR  
Paul W. Sowan

### Editorial Team

Editor of *Subterranea*: Nick Catford  
Editorial Assistants: Martin Dixon & Linda Dixon  
Layout: Martin Snow  
Graphics: Tim Robinson  
Proofreading : Stewart Wild

Bob Templeman

### Ex Officio

Chris Rayner: SB Meetings

Newsletters of Subterranea Britannica are published by the committee of Subterranea Britannica. Original articles, book reviews, press cuttings, extracts from books and journals, letters to the Editor etc are welcome.

However the Editor reserves the right not to publish material without giving a reason.

The committee of Subterranea Britannica and the Editor do not necessarily agree with any views expressed and cannot always check the accuracy of any material sent in.

Printed by Hillary Press Ltd. 75 Church Road Hendon London NW4 4DP  
Telephone: (020) 8203 4508 Fax: (020) 8203 0671

Subterranea Britannica A Company limited by Guarantee Registered in England and Wales Registration No. 6447148  
Registered Charity Number 1141524 Registered Office: 5 Railway Cottages, Old Station Way, Bordon, Hampshire GU35 9HH



## Chairman's Welcome

**Martin Dixon**

A very warm welcome to all new members and 'welcome back' to those renewing their membership. To keep in touch with events and news items, I'd encourage recent joiners to subscribe to our email lists – 'subbrit' for general chit-chat and 'announce' for official news and events. Plus we now have Facebook and Twitter channels for those who are into social networking.

The Committee is reviewing our 2011 accounts as I write this, and very encouraging they are too. Despite increases in postage rates and publications, there are significant reductions in postage and stationery costs (£1,100) following our move to more electronic communication, and a healthy reduction in web fees (almost £800) as a result of Richard Seabrook's sterling work. Donations have also increased, including support for John Smiles' commendable project at Wartling to weather-proof the Rotor bunker there. This position supports having limited the rise in membership fees to only £1 this year, with no further increase planned for 2013. We have claims in (but as yet no confirmation) for £13,000 of retrospective Gift Aid from HM Revenue & Customs (thanks to a tremendous effort by Sue Monsell in the last quarter of 2011). The plan, assuming the claim is approved, is to use the money for new projects rather than just 'more of the same'.

Underground space has been in the media quite a bit over recent months. As well as the usual specialist documentaries including the splendid *The Tube*, recent BBC series of *Britain's Heritage Heroes* and Michael Portillo's *Great British Railway Journeys* have both had regular underground excursions as part of their tours of the UK. Sadly, other coverage is less welcome and has included vandalism and theft by unscrupulous people. British Transport Police detained some "explorers"

overnight on London Underground's Piccadilly Line at Aldwych who had accessed the station via the running rails. Others were arrested on the Post Office Railway having allegedly derailed a train. The emergency services were too late to help a 40-year-old man who electrocuted himself while stealing metal from tunnels beneath St Lawrence's Hospital site in Bodmin, Cornwall.

The media often conveniently label all such felony as perpetrated by "Urban Explorers" – a term which has no clear definition. The majority of those who indulge in urban exploration (urbex) follow the mantra of "take only photographs, leave only footprints" but sadly a percentage use urbex as a front for illegal activity.

Those who attended last year's Sub Brit Manchester Study Tour will have seen the puerile graffiti in Victoria Arches – and at the same site we were unable to see much of the original WWII shelter signage which had been stolen in the preceding months. Some societies have decided to stop publishing site locations as part of an attempt to remove sites from the 'hit list' of those with malevolent intent.

The behaviour of a minority can not only destroy key features of a site, it very often prevents access for legitimate researchers who may follow later. Sub Brit makes it very clear in our Memorandum and Articles of Association (available on the website) that members should only enter and record sites with the full approval of site owners and it is a huge pity that the actions of a selfish and criminal few can spoil the enjoyment of the silent majority.

Let's hope that positive coverage of our underground heritage in 2012 continues to eclipse stories of break-ins, breakages and burglary.

chairman@subbrit.org.uk

### ***Subterranea Index***

It is now possible to access the Index of published articles in *Subterranea* via the Sub Brit website.

It currently covers issues 1-20, previously published as hardcopy with the magazine.

The Index is searchable and includes a set of keywords for the articles. The index lives under a new 'Shop' tab alongside our Site Directory and other publications. We expect to publish the index for Issues 21-30 with *Subterranea* issue 31, and then it will be added to the online Index.

In future, we plan to expand the 'shop' section as part of the wider website refresh.

The link is <http://www.subbrit.org.uk/shop>.

### **Sub Brit Visits Weekend : Sussex**

We are now able to confirm the date for the annual Sub Brit Visits Weekend.

This year it will be based in Sussex; starting on Friday afternoon, 14 September, through to Sunday afternoon 16 September.

Please see the enclosed leaflet for more details and a booking form.



## Meet our Treasurer – Tony Radstone

Tony Radstone was born in Highbury, London, in 1952, and spent most of his youth in Edgware, northwest London. After marriage in 1978 he moved out of London to Bourne End in Buckinghamshire, where he still lives with his family.

At sixteen he joined Thomas Cook as a retail travel agent and a few years later started his own agency, around 1974. Embracing the internet, he created a web business specialising in escorted tours and coach trips, selling the business in 2009.

During his time in the travel industry he served on the Aviation committee of the Association of British Travel Agents and was a director of Worldchoice, an association for independently owned travel agents with over six hundred shop members. He is still the London regional chairman of Worldchoice.

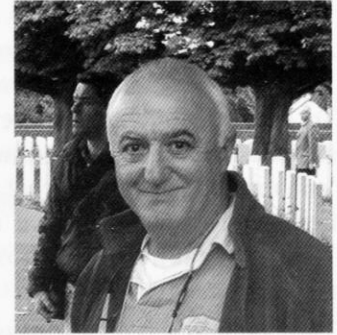
Tony was a member of Marlow Round Table until he had to leave due to the age rule, and moved on to be a member of Marlow Forty One Club, in both cases serving as Treasurer, and Chairman of the latter. As a member of the Marlow Regatta Committee he had the

responsibility of running the bars – two truck loads of beer and a pallet of Pimms and the odd sore head in the town the next day!

Arranging private tours to battlefield areas developed his interest in military history, in particular underground sites, both World War I and II, and especially the Cold War. He has been a member of Sub Brit for over ten years for this reason. A self-confessed computer nerd, he builds his own systems, and acts as helpdesk and webmaster for many friends.

His other interests are canal boating, having a trailable narrowboat, using this in the UK and in France, where he can enjoy both the countryside as well as industrial architecture – especially the tunnels!

He also likes Country music, but someone has to!



## SUBTERRANEA BRITANNICA DIARY Summary of Forthcoming Events 2012

### Sub Brit specific events

- 3 May Paddock Standby Cabinet War Room open  
katy.bajina@networkhg.org.uk
- 4-7 May SB Study Tour Jersey
- 16 June SB Committee Meeting
- 1 July Copy deadline for *Subterranea 30*
- 14 & 15 July Cuckfield ROC Post  
open for Festival of British Archaeology  
Book via markrussell666@msn.com
- 15 July SB members Day at Kelvedon Hatch
- 21 July Paddock Standby Cabinet War Room  
open for Festival of British Archaeology.  
No booking required.
- End August *Subterranea 30* published
- 14-16 September SB UK Visits weekend – Sussex
- 6 October SB Committee Meeting
- 13-14 October SB Autumn Conference  
and visits, Liverpool
- 1 November Copy deadline for *Subterranea 31*
- Mid-December *Subterranea 31* published

For more information, email [info@subbrit.co.uk](mailto:info@subbrit.co.uk)  
or contact the Society concerned

### Other underground-related events

- 14 April, 20 May, 12 Jun, 12 July, 14 Oct  
Coleshill (near Swindon) World War II Walks, where  
the Auxiliary Units were based.  
Book via the National Trust on 01793 762209.  
Cost is £3 pp + £1.95 booking fee.
- 29 June–1 July NAMHO conference Quarry Bank Mill  
[www.derbysec.org.uk/namhoconference2012](http://www.derbysec.org.uk/namhoconference2012)  
Summer – various weekends:  
Coleshill Auxiliary Unit:  
Replica Operational Base project. More information on  
<http://www.churchillsundergroundwar.org.uk>.  
To volunteer, contact Richard Alexander at  
[churchills\\_underground\\_war@yahoo.co.uk](mailto:churchills_underground_war@yahoo.co.uk)
- 14-29 July Festival of British Archaeology  
<http://festival.britarch.ac.uk>
- 10-16 August AIA Conference, Chelmsford  
[www.industrial-archaeology.org.uk](http://www.industrial-archaeology.org.uk)
- 6-9 September Heritage Open Days  
<http://www.heritageopendays.org.uk>
- 22-23 Sept London Open House weekend  
<http://www.londonopenhouse.org>

## NEWS – ARCHAEOLOGY

### Souterrains in Ireland

Early issues of the *Bulletin of Subterranea Britannica* (no issue of which title has appeared for several years) frequently contained articles on Irish souterrains, and similar archaeological sites from Cornwall. Indeed it was gratifying in 2010 at a conference at the University at Cork to find *Subterranea Britannica* well-remembered within the Archaeology Department on this account.

Souterrains are generally cut-and-cover trenches, usually more or less sinuous on plan, with dry-stone walls and stone slab ceilings. Some have a single entrance, others have two. Some have domed chambers and/or low creeps as if deliberately to make access difficult. They are especially characteristic of the western fringes of the British Isles and of France, especially Brittany. Members attending the Study Weekend in Cornwall visited one of these enigmatic tunnels. Proximity to the sea seems to be a common characteristic.

A recent paper in *Current Archaeology* reviews sites around Dundalk in County Louth, in the northwestern part of the Republic of Ireland, as the building of a new motorway has allowed a long continuous strip of land to be sampled.

The authors describe souterrains as the ‘underground castles’ of early medieval Ireland, used as strongholds and escape tunnels, dating (in Ireland) from the ninth to eleventh centuries AD. They are closely associated with ringforts (enclosed farmsteads rather than deliberately constructed defensible positions). At the Carn More ringfort, for example, the souterrain provides a safe passage from within the farm building to a sally-port beyond the encircling palisade or bank.

Upgrading the Irish A1/N1 and M1 in North Louth has allowed detailed examination of five large souterrains, one small one, and four associated ringforts. Extrapolation of numbers from the sample strip of land affected by motorway construction suggests a density of one ringfort to every 35 to 40 hectares in the non-mountainous part of the district. An archaeological survey of County Louth in 1991 recorded 300 identified ringforts and 290 known



The entrance to a typical Irish souterrain

or possible souterrains. Based on the recently examined sample, the authors suggest the total numbers might be as many as 600 such sites. The construction of these tunnels is related to invasions by the Vikings from 795 AD to 850 AD.

Double-entrance and single-entrance souterrains have been recognised. The first category was clearly suitable for escape, from within to outside a ringfort. That at Carn More 1 has a length of 20 metres and has a zig-zag plan.

Single-entrance souterrains were more elaborate hiding-places and, having but one way in, would give a discoverer no clues as to their internal layout or underground route. These ‘refuge souterrains’ are found some way beyond ringfort margins, and are generally larger and equipped with internal security features. One at Newtownbalregan is 45 metres long, and one at Tateetra 70 metres.

Single-entrance or ‘refuge’ souterrains are also interpreted as having a cellar or storage function or zone, a security zone with bends and obstructions in the tunnel and provision for stout timber doors, and an innermost and generally spacious end chamber. One such end-chamber is cited as having a floor area of 14 square metres.

The authors’ paper continues to address questions of ventilation, drainage, and lighting.

SOURCE: ROYCROFT, Niall, 2012, Escaping the Vikings: souterrains in County Louth, Ireland. *Current Archaeology* 22(11)(263), 20–27.

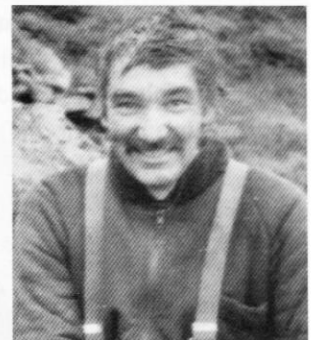
### Unsuspected underground hazard at Peterborough, Cambridgeshire

A young couple walking along outside a Peterborough nightclub were alarmed last year when a manhole cover a few metres from them was blasted into the air, followed by flames. This is apparently the second such event at a Peterborough BT site in November 2011. Electrical faults have been blamed.

SOURCE: TAHIR, Tariq, 2011, Manhole blast shoots fireball into the street. *Metro*, 24 November 2011, page 39.

### Ian Tyler and Keswick Museums, Cumbria

The museum of minerals and mining in Keswick has not, contrary to rumours, closed. But it is offered for sale by the proprietor, Ian Tyler, as a going concern. Ian and his late wife Jean first established the museum at Caldbeck 24 years ago, later relocating it to the centre of Keswick.



Ian Tyler

*Subterranea Britannica* members met Ian and admired his superb collection of minerals and mining relics during a Study Weekend in Cumbria a few years ago. Ian and Jean also established Blue Rock Publications, and in the course of twenty years have published a dozen books

and the mines of Lakeland and district. A thirteenth volume, *'The mines of Cross Fell and the Pennines'*, will be published in March 2012. Ian also formed 'MOLES' (Mines of Lakeland Exploration Society).

Well beyond retirement age, and finding the journey from Carlisle to the Museum time-consuming, he now intends to hand the museum on to new ownership and management, to allow him to enjoy more of the Lake District. The museum remains open, on a winter timetable, for the time being. Further information at: [www.keswickminingmuseum.co.uk](http://www.keswickminingmuseum.co.uk).

SOURCE: TYLER, Ian, 2011, Keswick Museum. *Newsletter Northern Mine Research Society*, November 2011, 11–12.

## NEWS – HEALTH AND SAFETY

### Higher than normal radiation at MoD sites

The Ministry of Defence has revealed that fifteen of its present or past UK sites are contaminated with radioactive material. This has nothing to do with nuclear weapons or nuclear reactors; the radiation is from the radioactive isotope radium, compounds of which (mixed with cadmium or zinc sulphide) were used to paint the luminous hands and figures on instrument dials, scrapped and dumped in the 1940s and 1950s. The longest-lived isotope of radium, radium 286, has a half-life of 1,600 years, which indicates that by the years 3540 to 3550 the radiation level will have dropped to half its World War II level.

SOURCE: EDWARDS, Rob, 2011, MoD reveals new list of radioactive sites in UK. Second World War radium found at old military bases. Ministry 'unclear' over dangers of polluted plots. *The Guardian*, 21 December 2011, page 12.

## NEWS – MINING

### Great Condurrow Mine, near Camborne, Cornwall

Great Condurrow mine, worked for copper and tin to the south of Camborne, adjoins South Condurrow mine, renamed King Edward Mine in 1901. Great Condurrow was acquired by the Carn Brea Mining Society in 2008, and work is in progress at the surface site (the King Edward Mine Museum visited in 2011 by Subterranea Britannica) and underground. The 1937 headframe on Vivian's shaft is now Listed Grade II as it is the oldest intact example of eight such small headframes surviving in the county.



King Edward Mine in 1901

The listing description is as follows:

A particularly complete and unusually small example of a steel girder headframe ... uniquely constructed [by the Camborne School of Mines] for training purposes. The headframe takes the form of a steel girder tower set directly over the winding shaft, and is braced by a pair of extended legs called boomstays. The entire frame is braced and triangulated for strength, and set upon elongated bearers which are bolted down to a levelled platform surrounding the shaft opening.

The structure, now rusting badly, requires remedial work which is to be undertaken by the Carn Brea Mining Society using an anonymous gift of £6,000 made for that purpose. Graham Thorne's report described this project as 'a happy combination of sympathetic ownership, private generosity, skilled management, and committed volunteers'.

SOURCE: THORNE, Graham, 2012, Great Condurrow Mine – Camborne. *Industrial Archaeology News* 160, pages 21–22 [Cornwall]

### Geology and history of a failed oil-shale mining enterprise (1916–1921) at Setchey, Norfolk

Norfolk is seldom thought of as a mining county, although of course chalk mines at Norwich and the Grimes' Graves flint mines on the Suffolk border are well-known. But at Setchey, eight kilometres south of King's Lynn, a mine was sunk to a depth of up to 60 metres to work oil-shale from the Kimmeridge Clay (Jurassic). An account of the geology and history of this far from successful enterprise has now been published.

The operators, English Oilfields Ltd, were responding to a need for home supplies of oil during World War I, and hoping for as successful a business as was already established in West Lothian, Scotland. Oil shale does not actually contain oil. The sought-for material within the rock is an organic mineral called keragen which, when subjected to destructive distillation in retorts, yields hydrocarbons which are driven off by heat and condensed as a liquid fuel.

This has practical consequences for the manufactory. You can't just pump oil or gas out of the shale. You have to mine the shale, lift the lumps of rock up the shaft, and then heat them in closed retorts. If all is well, you will use less fuel in the process than the value of the fuel yielded by the distillation. There remains large volumes of useless spent burned shale: anyone familiar with the West Lothian landscape will recall the bright orange 'bings' or spoil tips, some of which remain in the landscape today.

Operations commenced in 1916, and by 1920 (the war of course was by then won) the stock market value of the company was several hundred million pounds. Investors had no doubt been tempted by reports of 'hundreds of millions of tons of free oil', allegedly sulphur-

free; a 21-metre-thick seam of natural paraffin wax; and 'an abundance of metalliferous minerals' to swell the hoped-for profits. In the event, very little shale was mined and retorted; the resulting oil had an objectionably high sulphur content (too complex and expensive to remedy using the technology of the day); and the vast reserve of paraffin wax and metalliferous ores proved not to exist. The company crashed in 1921 and the entire undertaking was abandoned.

SOURCE: GALLOIS, Ramues, 2012, The Norfolk oil-shale rush, 1916–1921. *Proc. Geologists' Association* 123 (1), 64–73.

### **Shale gas fracking admitted to have triggered two small earthquakes near Blackpool, Lancashire**

Cuadrilla Resources, a firm engaged in seeking and it hopes extracting shale gas near Blackpool, has admitted probable responsibility for two small earthquakes which it appears were triggered by its drilling and fluid injection procedures. The method has been controversial in the USA and England, and has been halted as a result of unease over side-effects in France.

On the other hand, a 25 percent slump in North Sea gas production in the second quarter of 2011, leading to increased oil imports, has redoubled hopes for home production of shale gas.

SOURCE: ANON, 2011, Miner owns up to guilt over quakes. *Evening Standard*, 2 November 2011, page 40; MACALISTER, Terry, 2011, North Sea gas slump may provides boost for controversial shale projects. *The Guardian*, 30 September 2011, page 35.

### **Four dead and 57 trapped after explosion in coal mine, China**

Seven injured miners were rescued from the Qianqiu shaft in Sanmenxia, in central Henan province, China, and another thirteen managed to escape after an underground explosion followed by a small earthquake. However, four are known to have died and 57 are thought to be trapped underground.

China's mine safety record is currently improving: almost 7,000 miners died underground in 2002, whereas the number was 2,433 in 2009. This appears to be a result of a campaign to close down illegal mines. Nevertheless, the record is still bad compared with the developed world.

SOURCE: BRANIGAN, Tania, 2011, Four die and 57 trapped on blast at mine. *The Guardian*, 6 November 2011, page 25.

## **NEWS – MILITARY**

### **21 German soldiers found in WW1 tunnels**

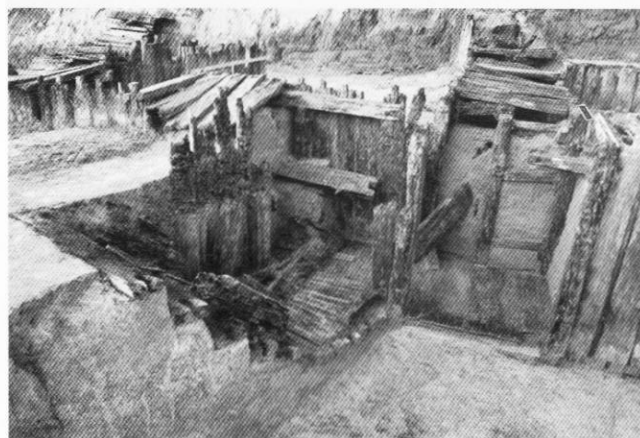
Twenty-one German soldiers entombed in a perfectly preserved World War I shelter have been discovered 94 years after they were killed.

The men were part of a larger group of 34 who were buried alive when an Allied shell exploded above the tunnel in 1918 causing it to cave in. Thirteen bodies were recovered from the underground shelter but the remaining men had to be left under a mountain of mud as it was too

dangerous to retrieve them. The dead soldiers were part of the 6th Company, 94th Reserve Infantry Regiment.

Nearly a century later French archaeologists stumbled upon the mass grave on the former Western Front during excavation work for a road-building project. Many of the skeletal remains were found in the same positions the men had been in at the time of the collapse, prompting experts to liken the scene to Pompeii.

A number of the soldiers were discovered sitting upright on a bench, one was lying in his bed and another was in the foetal position having been thrown down a flight of stairs.



Excavated WW1 tunnel

As well as the bodies, poignant personal effects such as boots, helmets, weapons, wine bottles, spectacles, wallets, pipes, cigarette cases and pocket books were also found. Even the skeleton of a goat was found, assumed to be a source of fresh milk for the soldiers.

Archaeologists believe the items were so well preserved because hardly any air, water or light had penetrated the trench. The 300ft-long tunnel was located 18ft beneath the surface near the small town of Carspach in the Alsace region in France. Archaeologists also uncovered the wooden sides, floors and stairways of the shelter which was big enough to shelter 500 men with 16 exits. It would have been equipped with heating, telephone connections, electricity, beds and a pipe to pump out water.

The French attacked the shelter on March 18, 1918 with aerial mines that penetrated the ground and blasted in the side wall of the shelter in two points.

It is estimated that over 165,000 Commonwealth soldiers are still unaccounted for on the Western Front.

SOURCE: *Daily Telegraph*, 10 March 2012

### **Bank of England stores its gold in WWII air-raid shelter canteen**

Despite the financial crisis, it seems Britain still has some money left in the Bank of England's vaults beneath London. In fact, there are stacks of gold bars worth £156 billion stored in an old canteen deep below the streets of the capital.

The piles of 28lb 24-carat gold bars are stacked on simple blue shelves beneath strip lighting. One image alone

shows around 15,000 bars or 210 tonnes of pure gold, with a value of approximately £3 billion.



Gold bars stored in the former canteen beneath the Bank of England

On the walls of one of the vaults, posters from the 1940s are still visible, from when the vast room was used as a canteen. The walls must be literally bombproof as they were used by bank staff as air-raid shelters during World War II. The old-fashioned posters that hang around the room depict sunny climes, luxury cruises and happier times – which may be as welcome a sight as the valuables for many.

Three-foot-long keys are needed to unlock the doors that guard the rooms holding the gold – but sadly not all of it belongs to us. Some is deposited by foreign governments as well as our own. Different shapes and marks distinguish the varying sources of the wealth

SOURCE: *Daily Mail online*, 3 February 2012

### German U-Boat bunker for rent

Two German government authorities are in conflict over a huge World War II submarine bunker near the northern German city-state of Bremen, which is to be rented out for commercial use.

The ‘Valentin’ bunker, 426 metres long and 33 metres high, was constructed using the forced labour of tens of thousands of people between 1943 and 1945. A satellite to the concentration camp Neuengamme was set up to accommodate the work, during which 1,600 people are thought to have died.

According to a report in *Die Welt* newspaper, the German Institute for Federal Real Estate (BIMA), which runs



Valentin U-boat bunker

the site, now wants to rent parts of the bunker for commercial use. But, according to the local State Office for the Preservation of Historical Monuments, this would involve the destruction of walls and fences, seriously damaging the building’s character.

The building was used as storage space by the German military until 2011. When BIMA took over management of the building, officials decided to rent out the main central hall as well as a three-storey side building.

The German state is also investing €3.8 million in a memorial and permanent exhibition on the Valentin bunker; this is expected to be completed in 2015. The building was opened for pre-arranged tours in May 2011.

The second-biggest above-ground WWII bunker in Europe was originally intended as a huge wharf to build submarines, and would have become the biggest fortified wharf in the world.

But in March 1945, when the building was close to completion, having already used 1.2 million tonnes of concrete and steel, British bombs tore huge holes in the building. The 4.5-metre-thick ceiling was not yet reinforced enough to withstand the bombs, and the Nazi leadership was forced to give up the building site. By this stage in the war, Germany was in no position to begin mass-producing new submarines in any case.

SOURCE: *The Local – Germany’s news in English*, 5 Jan 2012

### Plans to feed Ulster in event of nuclear war

Secret contingency plans for either conventional or nuclear war in 1981 included a stock of thousands of cooking implements held on behalf of the government throughout Northern Ireland, previously classified files reveal.

Hundreds of boilers, about 80 field cookers, more than 2,500 baking trays and more than 100,000 pieces of plastic cutlery were stockpiled in readiness should the province be attacked by the Soviets, papers released under the 30-year-rule reveal. However, a bulky file dealing with the contingency arrangements acknowledged that “the quantities are not large enough to meet completely the needs of the emergency feeding service”.

The file contains a series of war plans, some of which relate to England and Wales, from which Northern Ireland’s plan appears to have been adapted. The file includes a sheet of hand-written calculations by an official, seemingly in relation to the quantities of food which would be required depending on how much of the population survived an initial attack.

What appears to be the most recent war plan in the file says that in a pre-attack warning period the government would take control of food and introduce rationing. “Any documented rationing scheme, however simple, would take several weeks to implement even if some covert preliminary action could be taken to prepare the way.”

The file says that any nuclear attack on the UK was at that time expected to be in the region of 200 megatons –



thousands of times more devastating than either the atomic bomb dropped on Hiroshima or that which devastated Nagasaki in 1945.

A restricted diagram in the file demonstrates what a three-megaton surface blast centred on Belfast was expected to level, with concentric circles indicating the level of destruction out as far as Ballyclare and Crumlin. It is not clear from the file who drew the map, nor does the key make entirely clear what each of the concentric circles represent.



Main entrance to the Ballymena RGHQ. Photo Nick Catford

The documents also reveal that in a post-nuclear attack world where the UK government was unable to continue to function, a system of regional government units would be established in England and Wales “based on the 10 home defence regions”.

However, it is not clear from the file whether any such system had been devised for Northern Ireland and whether the province would be a single regional ‘defence region’ or would be broken up into smaller units such as the 26 local councils.

A nuclear bunker for Northern Ireland’s government ministers and officials in Ballymena was not completed until the end of the 1980s and the underground building is still maintained in readiness for an attack.

SOURCE: *Belfast News online*, 25 March 2012

### **First World War tunnels at La Boisselle, France**

A long-term archaeological, historical, geophysical, genealogical and technical investigation of a 2-hectare First World War site at La Boisselle in northern France was announced in June 2011 as due to commence in October that year. The Anglo-French team intends to begin this year’s work in May. The location lies at the epicentre of the Somme battlefield. Known to British troops as ‘The Glory Hole’, the sector was of strategic importance from the earliest days of trench warfare between French and German forces, throughout the Battle of the Somme period from June to November 1916, and in 1918 when it was overwhelmed by a German offensive before finally being liberated in September. The site contains French, British and German trenches (front line

and communication) and associated features such as shelters, saps, observation post and mortar positions. Part of the study involves the exploration and archaeology of a complex four-level, French, British and German tunnel system. It has already been established that within this 10-kilometre labyrinth of galleries lie the remains of 38 British and French miners killed as a result of subterranean offensive actions before 1 July 1916. Research into German losses is underway. The team believe that during the war there were 28 shafts or inclines within the site boundaries.



Tunnellers of 179 Tunnelling Company. © Mrs G Hillman

The trenches and other surface features are to be mapped with a variety of geophysical techniques including radar, resistivity, magnetometry and gradiometry; the entire surface area (which also includes a complicated linear field of mine craters both large and small occupying the old No Man’s Land) will be surveyed with Lidar. Underground galleries are to be laser-surveyed. The human remains known to be in the tunnels will not be disturbed – having been unrecoverable by their comrades during the war, they will today be equally inaccessible. Remains found during surface works will be recovered by forensic archaeologists and reburied after liaison with the local police and the Commonwealth War Graves Commission.

By June 2011 some tunnel sections had already been re-entered and found to be in surprisingly good condition, with the remains of tools and machinery, candle burns, a narrow-gauge railway, and even the tunnellers’ footholds. In several places the archaeologists have found names, graffiti and even poems written on the chalk walls.

It is believed that this is the first study of its kind to be undertaken on a First World War battlefield. It is hoped that the privately-owned site may ultimately be opened to the public as a war memorial.

A great deal more information can be found on the La Boisselle Study Group website:

[www.laboisselleproject.com](http://www.laboisselleproject.com)

SOURCE: La Boisselle Study Group

## Large public air-raid shelter found in Middlesbrough

Middlesbrough town centre's last remaining Second World War air-raid shelter has been found preserved under the streets.

A large bunker, designed to protect 367 people from Luftwaffe raids, has been tracked down below Linthorpe Road in the town centre. A jeweller's, a building society, a camping store, a pound shop and a clothing store now sit unassumingly above the hidden wartime structure.

The only give-away it was ever there is a fading sign nearby. Paint weathered for more than 65 years can still be easily read: ARP SHELTER FOR 367 PERSONS.



Photo Chris Twigg

Phil Hudson, Middlesbrough's emergency planning officer, has researched local shelters: "There were numerous ones all around the town at the time," he said. "This is the one we know least about. It's a big one and it's probably the only one left. It's an important bit of history. It was made by knocking through the cellars under the shops and possibly the former Shakespeare pub – now an amusement arcade – then extending the bunker behind the buildings. They used to knock all the cellars into one and put in extra steelwork to shore them all up." After the war, the basements were generally separated off again and handed back to their owners. But extended shelters such as the one on Linthorpe Road were boarded up and abandoned – technically the space didn't belong to anyone.

SOURCE: *Middlesbrough gazettelive.co.uk* 7 September 2012

## Nazi terror HQ now Topography of Terror Museum at Prinz Albrecht Strasse, Berlin

Cellars and the engine room of the former Berlin headquarters of the SS, Gestapo and Reich Main Security Office are now in use as a Topography of Terror Museum, unusual in the city in being on an authentic and original Nazi-era site. It was from here that the holocaust was administered.

The displays feature the German personnel rather than, at other holocaust museums, their victims. One wall is full of filing cards detailing the identities of those who

worked here as a vital part of the state 'killing machine': typically, it is reported, they were 'ambitious academics in their 30s who were keen to climb the career ladder'.  
SOURCE: Kate CONNOLLY

## RAF Daws Hill bunker to be demolished

The redundant bunker complex at RAF Daws Hill near High Wycombe will be demolished before summer 2012, subject to council consent. The Ministry of Defence has written to Wycombe District Council seeking permission to bulldoze the bunker which includes a warehouse, a building hosting a generator, a tanks building and office facilities.

The complex would be returned to Wycombe Abbey School as grass under the plan, which the MoD hopes to execute over the spring/summer period. When the site was leased from the school it was due to be passed back at the end of the lease period and the site restored to its original condition. The school are pressing the MOD to either demolish the bunker or at least collapse the top and level off the land, so they can then build a new accommodation block on the site.

RAF Daws Hill was sold to developer Taylor Wimpey in August 2011 but the firm leased back some of the 67 bungalows to the MoD until September this year to give the remaining service personnel time to move out.

The 20-hectare site was used as a base for visiting American forces but had been mainly used for storage purposes in recent years.



The main access stairs into the bunker. Photo Nick Catford  
SOURCE: *Bucks Free Press*, 15 March 2012

## Iran to use 'smart concrete' for protection against US bunker-busting bombs

As tension escalates between the US and Iran, American officials are increasingly concerned that the use of 'smart concrete' may render Iranian nuclear sites impervious to US bunker-buster bombs.

An article published on the Aggravate Research website stated that due to Iran's geographical situation, the country

is under constant threat of earthquakes. As a result, the website said, Iranian engineers are very good at developing “ultra-high performance concrete” (UHPC) which is among the toughest and most rigid building materials in the world.

It added that the new Iranian concrete, made on an indigenous formula, is now a major concern for Washington in addition to Iran’s uranium enrichment work, whose technology has been also indigenized. “Unlike conventional concrete, Iranian concrete is mixed with quartz powder and special fibres – transforming it into high performance concrete that can withstand higher pressure with increased rigidity,” the article stated.

Due to its combination, the new Iranian-made concrete is an excellent building material with peaceful applications like the construction of safer bridges, dams, tunnels, increasing the strength of sewage pipes, and even absorbing pollution.



Artist's impression of an Iranian bunker built from 'smart concrete'

However, the article said, like any dual-use technologies that carry both civilian and military applications, the UHPC can also be used to protect underground facilities from bombardment, which could pose a real headache for military endeavours into Iran.

According to the article, US Defense Secretary Leon Panetta recently expressed his concern that in case of a real conflict, the American bunker busters may not be able to penetrate Iran’s deepest bunkers should the UHPC be employed for military purposes.

In an interview with the *Wall Street Journal* on January 26, Panetta announced that more development work would be done and that he expected the bomb to be ready to take on the deepest bunkers soon.

Reflecting that the 30,000-pound bunker-buster bombs, known as the Massive Ordnance Penetrator, were designed to take out hardened fortifications, the *WSJ* revealed that “initial tests indicated that the bomb wouldn’t be capable of destroying some of Iran’s facilities.”

The US war agenda against Iran has gained momentum over the past few months. The United States, Israel, and some of their allies accuse Iran of pursuing military objectives in its nuclear energy program, with Washington and Tel Aviv using this pretext to threaten Iran with a military option.

Iran refutes such allegations, arguing that as a signatory to the nuclear Non-Proliferation Treaty and a member of the International Atomic Energy Agency, it has the right to use nuclear technology for peaceful purposes.

SOURCE: *PressTV*, 11 March 2012

### New Burlington files released

Files released at Kew at the end of December include the 1962 Cabinet Office War Book, a brief but chilling guide to Armageddon, as seen from Downing Street.

The War Book detailed the steps to be taken in Whitehall in the last hours before Russian hydrogen bombs rained down on London, including the removal of key civil servants to Burlington, a command bunker buried under 100 feet of earth at Corsham, Wilts.

The underground city was to be home to some 230 politicians and civil servants, the last government of the irradiated cinder that had once been the United Kingdom.

The document details how Harold Macmillan and a few chosen members of his Cabinet were to be helicoptered to Burlington from Horse Guards Parade, even as air-raid sirens sounded and V-bombers roared skyward in preparation for *Operation Visitation*, Britain’s portentously-named counter-strike against the Soviet Union.

Burlington, known as Turnstile at other times in its career, had only recently been completed and elaborate precautions were taken to protect its existence. Those earmarked to serve there were to be given little warning, just enough time to visit their homes, gather some personal effects and wish their families an anguished farewell.



The telephone exchange at Burlington. Photo Nick Catford “With the advent of the strategic missile it has become possible for a potential enemy to launch a full-scale attack on this country without any really detectable preparation,” warned the War Book. “We might thus (if the attack were to be launched at a time when there had been no obvious worsening of the international situation to put us on our guard) have very little time – probably less than an hour – to make preparations.”

To minimise panic the run-up to the end of the world, known as the “precautionary stage”, was to be shrouded in secrecy. The order to man Burlington would come from Cockpit, a planning cell in the Cabinet Office, only when nuclear war was imminent. The chosen few were to report to Marsham Street in Westminster, where buses would be waiting to ferry them to Kensington Olympia railway station. Whitehall departments were to be alerted by the codeword *Shadwell*, a system of coded messages being used to relay instructions. For example, *Grandee Golf Two One* meant “Cabinet have authorised institution of control of radio transmissions.”

Nuclear war was considered insufficient excuse for shirking. “Staff not assigned to specific duties at war stations should be informed that they were expected to work normally,” instructed the War Book. “If after attack their normal place of work is inaccessible they will be expected to report as soon as possible to the nearest Employment Exchange.”

Macmillan would have had a busy last few hours above ground, confirming the five members of Cabinet who were to accompany him to Burlington and appointing others as regional commissioners, endowed with the power of life and death over those unlucky enough to survive the fireballs. The Prime Minister, allowed two private secretaries and four shorthand typists for his personal staff, had also to consider his own demise. The War Book reminded him to appoint “first and second deputies” to authorise nuclear retaliation in the event of his death.

The helicopters would arrive quickly, flying in from RAF Little Rissington in Gloucestershire to a refuelling point ten minutes from Horse Guards. There was room aboard them for just 25 people.

“At an appropriate point the Prime Minister may speak to the President of the United States,” remarks the War Book, “principally about the use of (US nuclear) forces stationed in this country in respect of which a joint decision is required.”

One of Macmillan’s last constitutional acts would be to seek a Royal Proclamation instituting regional government. Separate arrangements for the Royal Family had been made, including the use of the Royal Yacht Britannia as a floating refuge, hidden in a sea loch in the north of Scotland.

SOURCE: *Daily Telegraph*, 30 December 2011

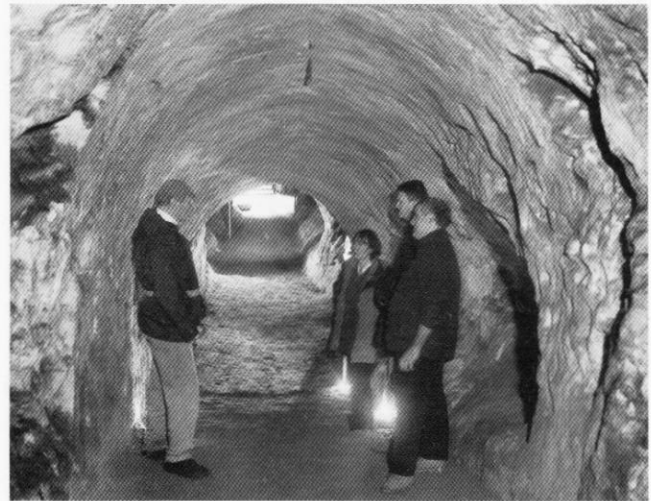
## NEWS – MISCELLANEOUS

### Cave Days in 2012 at Reigate, Surrey

The Wealden Cave and Mine Society offers public guided tours of the Barons’ Cave under Reigate Castle, and of the sand-mines east and west of Tunnel Road, Reigate, on selected Saturdays in 2012. During the last year a team of WCMS members has commenced a programme of improving the Tunnel Road East mine which it occupies under licence from Reigate & Banstead Borough Council.

Miscellaneous junk (the ‘wrong sort of junk’ of course) has been removed, and new displays created including a simulated World War II air-raid shelter complete with sound effects. Other displays relate to Surrey’s mining and quarrying industries and the Cold War era. Guided tours in the Tunnel Road West mine, by courtesy of a rifle club, offer visitors a dramatically lit view of one of Reigate’s most impressive subterranean landscapes.

The Reigate silver-sand mines are thought to date from the 18<sup>th</sup> – 19<sup>th</sup> centuries, and to have provided silica sand for glass-making furnaces on the banks of the Thames. The Barons’ Cave dates back certainly to 1596 when it was first mentioned in print, and very possibly to the construction of Reigate Castle itself in the eleventh century. The guides here explain what is known about this curious excavation, and recite the several theories concerning its original purpose.



The Barons’ Cave. Photo Nick Catford

2012 Cave days are Saturdays 12 May, 9 June, 14 July, 11 August and 8 September. Tours run from 10.00 to 16.00hrs starting at the lower entrance to the Barons’ Cave at the west end of the Castle grounds; and for the sand-mines, in the Tunnel Road tunnel. Entry charges are made, and a joint ticket for both tours can be had. There is no charge at the Barons’ Cave on 8 September, as it is then open free as part of the Heritage Open Days programme. Booklets and postcards will be on sale.

### ‘Caves’ survey at Nottingham

Nottingham, a ‘city of caves’ (500 or so of them), vies with Royston, Herts (one cave) as the spiritual home if not birthplace of Subterranea Britannica. In our early years we had a strong Nottingham contingent amongst our committee members, and our meetings were often held in the city museums’ offices at Brewhouse Yard.

All these ‘caves’ (all man-made of course) have been intensively surveyed and studied on several occasions. They were assessed, and many of them used, as air-raid shelters during World War II, from which period a dossier of plans survives.

The British Geological Survey has compiled and published a massive three-volume ‘*Register of Nottingham’s*

*Caves*', commissioned by the Department of the Environment. Several of our own members have conducted and published archaeological investigations. Tony Waltham has examined and reported on many of the caves as a professional engineering geologist, from which studies a volume for a non-specialist readership has been distilled.

Most recently, Trent & Peak Archaeology (one of the modern archaeological site investigation companies) has been conducting further investigations underground, of which an account has now been published in *Current Archaeology*. This provides an overview of Nottingham's caves and their uses from their first mention in AD 893 onwards. Recorded uses range from underground dwellings, cellars, secret escape tunnels and industrial sites (malt kilns, a tannery and a sand-mine) through to World War II air-raid shelters and a Cold War control centre.

The Nottingham Caves Survey project's aims were 'to investigate, record, archive, visualise and promote the caves' and was sponsored by English Heritage, the Greater Nottingham Partnership, Nottingham City Council, and the British Geological Survey. It extends the BGS work on the *Register of Nottingham Caves*, using a 3D laser scanner 'capable of recording 500,000 points per second at +/- 2mm accuracy'. From data collected, plans and sections can be generated. Additionally, 'flythrough' and 'flyround' videos can be produced. Examples can be viewed at [www.NottinghamCavesSurvey.org.uk](http://www.NottinghamCavesSurvey.org.uk).

### **City of Caves visitor attraction reopens, Nottingham**

The 'City of Caves' visitor attraction, with its entrance incongruously within one of the malls of the Broadmarsh shopping centre, reopened on 11 February 2012. The series of caves featured were excavated into a low sandstone cliff and used over the centuries for, amongst other things, a tannery and as World War II air-raid shelters. The entire mass of the shopping centre was built right across the cliff, but access to the caves has been retained via the basement.

Visitors now enjoy a series of displays illustrating the several periods and modes of use. The attraction is paired with another under the same management – the network of cells and tunnel under the Shire Hall at High Pavement, where 'performance tours' are on offer.

For details of these subterranean tourist sights see their websites: [www.cityofcaves.com](http://www.cityofcaves.com) and [www.galleriesofjustice.org.com](http://www.galleriesofjustice.org.com)

### **Underground Cannabis factory found in Somerset**

A cannabis factory worth around £130,000 has been discovered by police in one of Somerset's most unusual drugs raids. In February police seized 130 plants from where they were being grown in two metal shipping containers – buried three feet underground.

A host of hydroponics equipment, electricity and a

running water supply was found inside the containers. The only access route was a small pipe barely large enough to fit a man inside. The factory – concealed beneath farmland in Shipham – had been running off the main power supply of a nearby building which had been tapped into.



Inside the buried trailers

A 45-year-old woman was arrested on suspicion of production of a controlled drug and bailed until April. The warrant came after members of the public tipped off police about the factory and officers used a helicopter with a thermal-imaging camera to detect the site.

Shipham PC Kat Forrest said: "Friday was a successful day – several departments from the constabulary worked together to effectively locate and dismantle an illegal drugs operation."

SOURCE *Weston, Worle & Somerset Mercury*, 29 February 2012

### **Crystal Palace (Low Level) Station**

Crystal Palace station – called Crystal Palace (Low Level) until the High Level station closed in 1954 – is arguably the finest surviving piece of architecture from the Crystal Palace (destroyed by fire on 30 November 1936) and its pleasure grounds of 1854. For those with an interest in underground places, it can be reached by London Overground trains from Dalston Junction via the Brunels' Thames Tunnel.

The station was at first a terminus, built on a branch line expressly laid to cater for the crowds visiting the Palace (relocated – and extended – from the Great Exhibition of 1851 at Hyde Park). Within a few years the original terminus building was replaced by the present grand structure, and the line extended through a new tunnel towards Balham and London Victoria. The station is in two parts, the northern side being by far the most impressive. Two platforms on the south side cater for Croydon to London Victoria trains.

On arrival at the London Overground platforms the visitor has a grand view of the Crystal Palace tunnel portal, and the quite splendid flights of steps up to booking hall level and the station exit. Following on up to the site of the Crystal Palace building is again an uphill

trek. Those Victorian visitors certainly got their exercise! Work is now due to start on installing three lifts to allow this century's faint-hearted weaklings and of course the more deserving disabled and elderly to avoid the steps. But the grand flights of steps survive as the structure is Listed Grade II. As a plus, the grand Victorian booking hall is to be refurbished and reopened to passengers.

Once at Crystal Palace you can explore what is left of the grounds, especially the 'dinosaurs' (Victorian-era life-size models of extinct animals – only some of which are dinosaurs). There are excellent views eastwards and northeastwards over London from this hilltop location. Brunel's south water-tower base remains: you can peer into the interior via a gated tunnel. And the Crystal Palace School of Engineering, the only part of the Palace buildings to survive as a usable structure, now houses a rather good Crystal Palace Museum. There are plenty of agreeable pubs, cafes and restaurants along Westow Hill and Westow Street, and a good bookshop.

### **New Embankment Substation for London Underground**

London Underground's Embankment substation was closed in 1957 when it was replaced by a new substation. The old substation was housed in a vast underground chamber beneath Victoria Embankment Gardens and accessed from 'Pages Walk' which is a long and steeply inclined interchange subway that was provided between the Bakerloo and District lines with access from one end of the Bakerloo Line platforms (5 & 6). The subway was not popular with passengers and was closed on 2 March 1914 when the station was rebuilt with escalators. It was retained as a cable way and now also houses communications equipment.

There had been a number of proposals for reusing the underground chamber and in 1998 LT Property commissioned a feasibility study for converting the substation into a nightclub. Nothing came of this and when visited by members of Sub Brit in 2008 the vast chamber was empty and unused.



Embankment substation chamber in 2008. Photo Nick Catford

The old substation has now been reused as part of a programme of fourteen substation replacements on London's sub-surface lines. Its purpose is to increase passenger capacity by allowing more modern trains to be run. Eventually it is expected that the planned 191 new Bombardier S Stock trains will allow a 65 percent capacity increase on the Circle and Hammersmith & City lines, 24 percent on the District line and 27 percent on the Metropolitan line.

Construction work began last October with the demolition of various structures, including a long-abandoned overhead crane, brick walls of varying vintages, and walkways that had become dangerously unstable.

The work was especially complex as all personnel, materials and equipment could only reach the site via one small access shaft that originally formed part of the ventilation system. On the last weekend of October 2011, and after months of project work and planning, everything was ready for the sub-station equipment delivery.

The three 2,500kW KNAN transformer-rectifier units weighed 12,500kg each and they only just fitted between the roof beams of the old power station. It was clear that the ventilation shaft was no longer sufficient, so a larger main ventilation shaft was opened for the first time. At 6am on Saturday morning a 150-ton crane and three low-loaders carrying the transformer-rectifiers arrived on site, and the complex lifting operation began. By nightfall the first stage of the operation was complete with each of the transformer-rectifiers having been safely lowered out of sight ready for assembly.

Next day the low-loaders returned carrying the switchboards and remaining equipment, and installation resumed. By 8pm on Sunday evening the lifting operation was complete, and on Monday morning, when the protective roadways were removed, it is unlikely that any passing commuter could have guessed at the scale of the operation that had taken place.

SOURCE: Sub Brit web site

[www.subbrit.org.uk/sb-sites/sites/e/embankment\\_station/index.shtml](http://www.subbrit.org.uk/sb-sites/sites/e/embankment_station/index.shtml) and *The Rail Engineer*, February 2012.

### **Chameleon boiler suits?**

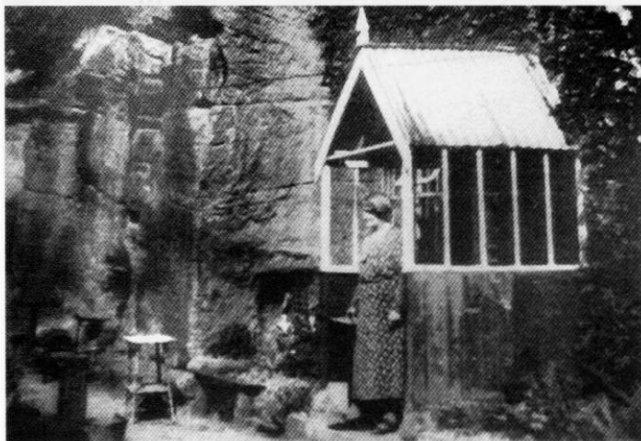
Chinese chemists have devised a fabric that changes colour according to ambient oxygen levels in air. Applications are envisaged in the mining industry, and high-altitude and space explorers. A combination of water-resistant non-toxic oxygen-sensitive dyes is incorporated into the fabric. Colour changes in the cloth are monitored using a digital camera. Might a chameleon boiler suit be the latest 'must-have' high-tech gimmick for gadget-hungry Sub Brit members?

SOURCE: RICHARDS, Elinor, 2011, Colour-changing dyes give a readout that can be read with a standard digital camera: chameleon clothes detect low O<sub>2</sub> levels. *Chemistry World* 8(11) November 2011, page 20.

### Restored Rock House opened in Kinver

A restored rock house built inside a cave has opened at Kinver, a National Trust property in Staffordshire. The Kinver Rock Houses date from 1770. One has been restored to show what life was like for residents in the 1930s. At one time, eleven families lived in the cave homes and it is believed they came about in response to a housing shortage for employees of the Hyde Iron Works. The restored home will tell the story of typical rock residents such as the Reeves who lived here until 1937. When the last two families moved out in the late 1950s the eleven homes began to fall into disrepair. The National Trust bought the complex of rock houses in the mid-1960s, each comprising a bedroom and separate living area. In 1964 the National Trust paid £113 and 19 shillings for a Rock house.

Three levels of homes were constructed in the rock. None of them had electricity or running water or toilets – families shared an outdoor privy. Three homes on the bottom tier were restored and opened to the public in the 1990s. The trust has since restored one of the homes on the top tier which was converted into a tea-room by the Reeves family and which is still used as a tea-room. The Reeves moved into one of the rock houses in 1932. Mr and Mrs W Reeves lived in one house. Next door their adult son and his wife lived with two children in a house known as the Martindale Caves. The Martindale Caves is the latest rock house to be restored.



The Reeves family home in 1935

Rock House custodian Mike Parker said: “The new house gives us a chance to tell more stories about the people who lived here and add another dimension to the visitor experience. Many of the families who lived in them would have been connected to the Hyde Works. When that closed in the late nineteenth century people began moving away from the Rock Houses. There would have been a mix of owner-occupiers and tenants. It’s likely the family would have paid a bit less for the rock house than for a conventional home with similar dimensions, because of the lack of facilities.”

Last year, the Rock Houses had a record number of visitors, exceeding the 12,000 figure for the first time.

SOURCE: *BBC News (Stoke & Staffordshire)*, 1 March 2012

### SERIAC in Kent in 2013

The South Eastern Region Industrial Archaeology Conference is held in turn in the southeastern Counties, and run by the industrial archaeology society for that county. Berkshire, Greater London. Hampshire, Kent, Surrey and Sussex all take turns.

Kent has been missing for some years, in the absence of an IA group for that county. However, thanks to a group of members of the Kent Archaeological Society, there is to be a meeting in Kent in 2013 – probably in or about April or May. The venue may be Chatham or Dartford. Underground archaeology is well-represented on the working group – Mike Clinch, Rod Le Gear and Paul Sowan are all members!

### National Association of Mining History Organisations: 2012 Conference to be based at Quarry Bank Mill, Styal, Cheshire

The 2012 NAMHO Conference is being hosted by the Derbyshire Caving Club, and will be based at Quarry Bank Mill, Styal, near Wilmslow, Cheshire from 29 June to 1 July. The conference theme is ‘Copper, lead, cobalt, salt, coal, fireclay and limestone: Cheshire’s mining history’. As usual there will be a full programme of lectures and surface and underground visits in and around Cheshire and north Staffordshire. Full details and booking information will be at

<http://www.namhoconference.org.uk> .

### Mafia boss caught in underground lair near Naples, Italy after 15 years

The supposed head of the Casalesi clan of the Camorra has been captured in an underground hideout at Casapasenna, a town around twelve miles from Naples. A bulldozer and a crane were brought in by armed officers as they launched a raid on the hiding spot of Godfather Michele Zagaria – nicknamed Capastorta (crooked head).

The 53-year-old was on Italy’s 20 Most Wanted List and had been sentenced to life in his absence for murder, extortion, robbery, and Mafia association. Police reported a thickness of five metres of concrete between the lair and the floor of the house below which it had been excavated. Access from within the house was via a sliding door on rails in one of the bedrooms. The fugitive’s first words on being taken were reportedly ‘You’ve won. The State has won’. He is accused of running an illegal toxic-waste transport and disposal concern. About two billion Euros of the firm’s assets have been seized.

Zagaria was able to monitor the arrival of his captors using closed-circuit television, but was unable to escape as a result of a faulty mechanism on his escape hatch. Police had blocked all known or suspected exits, and cut off the electricity supply, so Zagaria’s last hours in hiding

were spent in darkness. Police took three hours to drill into the bunker. Their prisoner was led away in handcuffs and driven off in a cavalcade of sirens and cheering officers beeping their horns.

SOURCE: HOOPER, John, 2011, "The State has won". Police jubilant as mafia boss caught in underground lair. *The Guardian*, 8 December 2011, page 31.

### **Mayor Boris suggests replacing the Hammersmith flyover with a tunnel**

The Hammersmith flyover in west London could be replaced by a tunnel when it is finally pulled down, says Boris Johnson.

The Hammersmith flyover is causing traffic misery every day as engineers battle to fully reopen the bridge in time for the Olympics. The Mayor has now raised the possibility that it could eventually be replaced by a tunnel. The 50-year-old flyover, which carries the A4 over the centre of Hammersmith, was shut on December 23 last year when steel cables that hold the 900-metre-long concrete structure together were found to have corroded. Investigations over Christmas revealed that some cables had snapped, raising concerns about the four-lane structure's ability to carry traffic volumes of about 90,000 vehicles a day.

It is now open to one lane of traffic in each direction. Repair work will focus on strengthening six of the sixteen spans of the structure to ensure that they can carry full traffic loading by the Olympics. After the Games, engineers will strengthen the remaining ten spans of the flyover.

A spokesman for the Mayor said: "The priority is to get the Hammersmith flyover fully operational as soon as possible. That work will keep the flyover open for 10 to 15 years during which time it would be prudent to consider what a replacement might be. The Mayor believes every option should be considered including the possibility of a tunnel which would also provide the great benefit of freeing up around 900 metres of land."

SOURCE: *London Evening Standard*, 26 January 2012

## **NEWS – BOOKS & PUBLICATIONS**

[Most books noticed in this section are in the personal collection of Paul Sowan. *Subterranea Britannica* does not receive review copies. Mining and related books are often obtainable from Mike Moore (member) of 53 Vineyard Drive, NEWPORT, Shropshire; tel: 01952 405105 / Email [mike@moorebooks.co.uk](mailto:mike@moorebooks.co.uk) / website [www.moorebooks.co.uk](http://www.moorebooks.co.uk) ]

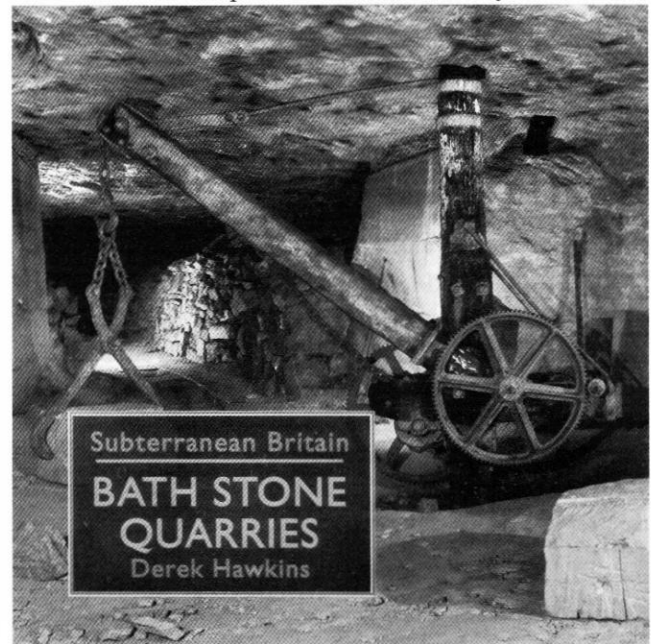
### **Bath stone quarries, Somerset and Wiltshire**

DETAILS: HAWKINS, Derek [1958 – 0000], 2011, *Subterranean Britain: Bath stone quarries*. Monkton Farleigh: Folly Books Ltd: (4) + 216pp [ISBN 978-0-9564405-4-9]

This is a sumptuously illustrated book about most, if not all, of the underground building-stone quarries to the south and east of Bath: the well-known and very extensive labyrinths such as Box and numerous small workings as

well. In addition to informative text concerning the geology, history, and methods of quarrying, and colour photographs of the underground landscape, there are reproductions of extracts from historic maps showing how the quarry entrances related to quarry railways and inclined planes, and to the Kennet & Avon Canal and the Great Western Railway.

The emphasis is on the historic to modern quarrying, and to some extent with secondary uses for the quarried voids, although the World War II and Cold War uses are little more than mentioned. That aspect of the Bath stone quarries has of course already been dealt with in other recent publications, including issue 22 of our own *Subterranea* (April 2010). The book comes right up-to-date with photographs of recent consolidation work in the Combe Down quarries south of the city.



Derek Hawkins is a local man, born in Bathford in 1958, who has developed his underground photographic skills in the quarries for something like forty years and has worked in the local quarrying industry for much of that time. The book is highly recommended as an excellent overview of the Bath stone quarrying industry as a whole, and for its splendid depiction of underground landscapes. It is available at £24.99 + postage and packing from Moore Books.

### **Combe Down quarries, Bath, Somerset**

The extensive labyrinth of eighteenth-century and later underground building-stone quarries at shallow depth below Combe Down, south of Bath, have now been almost completely back-filled to protect the houses and conservation area above from subsidence. Bath & NE Somerset Council has published limited editions of two small illustrated hardback books to explain how and why this was done.

One (by Francis et al) is of the nature of an internal document for the information of professionals who may undertake similar backfilling work elsewhere; the other



(by Lord) is more in the nature of a souvenir for local inhabitants. The details are:

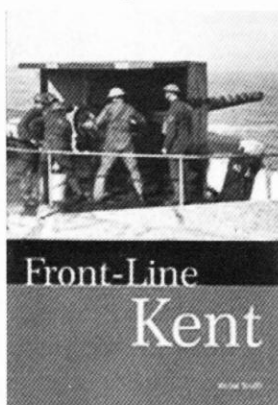
FRANCIS, Alan, Mike HOPE, and David ADAMSON, 2011, *The stabilisation of Combe Down stone mines: good practice guide*. Bath & NE Somerset Council: 142pp [500 copies printed]

LORD, Frances (ed), 2010, *The stabilisation of Combe Down stone mines: the saving of a village*. Bath & NE Somerset Council: 96pp [ISBN 978-0-9563829-3-4] [1500 copies printed]

### **Front-line Kent: an excellent book ruined by the graphic design people!**

DETAILS: SMITH, Victor T.C., 2007, *Front-line Kent: defence against invasion from 1400 to the Cold War*. Maidstone: Kent County Council: 112pp [ISBN 1-901509-64-8]

This is a reissue of an excellent book first published in 2001. Victor Smith is an acknowledged authority in this field, and the text and superb illustrations do exactly 'what it says on the tin'. There are chapters from 'Castles and cannon' to the Cold War. Supporting sections are a gazetteer of site and site descriptions (five pages), a bibliography (one page), and index (one page) and some notes on selected publicly accessible sites (one page).



The rather small print size is forgivable, as it means a great deal of information has been packed into an inexpensive book. But sadly the graphic designers have been let loose, resulting in around twenty pages of the text (around 17 percent) being rendered almost unreadable by being printed on dark blue, dark red, or otherwise dark coloured paper!

## **NEWS – TUNNELS & TUNNELLING**

### **Yet another Thames Tunnel in prospect?**

Transport for London has conducted a public consultation on two proposed new river crossings for London. The deadline for responses was 5 March, which seems a bit short given that your reviewer (Paul Sowan) saw no invitations to comment before 27 February!

One of the proposed new crossings is yet another tunnel under the Thames, from the Greenwich Peninsula (ie 'The Dome') to Silvertown on the north bank. The other, further downstream below Woolwich, is a new ferry from the Kent bank to Gallions Reach. The electronic address for representations was: [tfl.gov.uk/rivercrossings](http://tfl.gov.uk/rivercrossings).

SOURCE: Transport for London advertisement in *Metro*, 27 February 2012, page 25.

### **Canal tunnels to change hands**

British Waterways is being wound up, and its estate, 1700 staff and functions transferred to a non-governmental

charity to be called the Canal and River Trust. The handover of something like 2,200 miles of canals (and their tunnels of course) is scheduled to take place in April 2012.

In response to governmental demands, staffing has been reduced by about 25 percent in the last seven years. The £ 470m estate is third only in size to the Church of England and the National Trust, and includes (like them) a great many 'heritage assets'. Central Government has offered grant aid of £39m per annum for the next ten years, although this is not to be index-linked so will decline in value year by year.

The current income (from property and boaters' fees) is of the order of £65m per annum, and total annual expenditure about £160m. As government funding tapers off, the canals will be expected to eventually finance themselves, presumably by commercialisation and from additional income from the owners of the 44,000 boats on the system and from new users.

SOURCE: *National Council on Inland Transport Newsletter* 40 (Winter 2011/2012), page 1; CANAL AND RIVER TRUST, 2012, News from the waterways. *Industrial Archaeology News* 160, 15–16.

### **Manchester bank robbers dig 100ft-long tunnel**

Thieves in Manchester dug a 100ft (30m) tunnel to get to a cash machine. The theft happened overnight on Monday 2 January at Blockbuster in Fallowfield Shopping Precinct, Levenshulme

Thieves dug the tunnel directly under the cash machine and used machinery to cut through more than 15in (38cm) of concrete to steal the money. The tunnel started from a railway embankment at the rear of the shop, and went under a car park and beneath the foundations of the store. The passageway was about 4ft (1.2m) tall and had been fitted with lighting and roof supports.

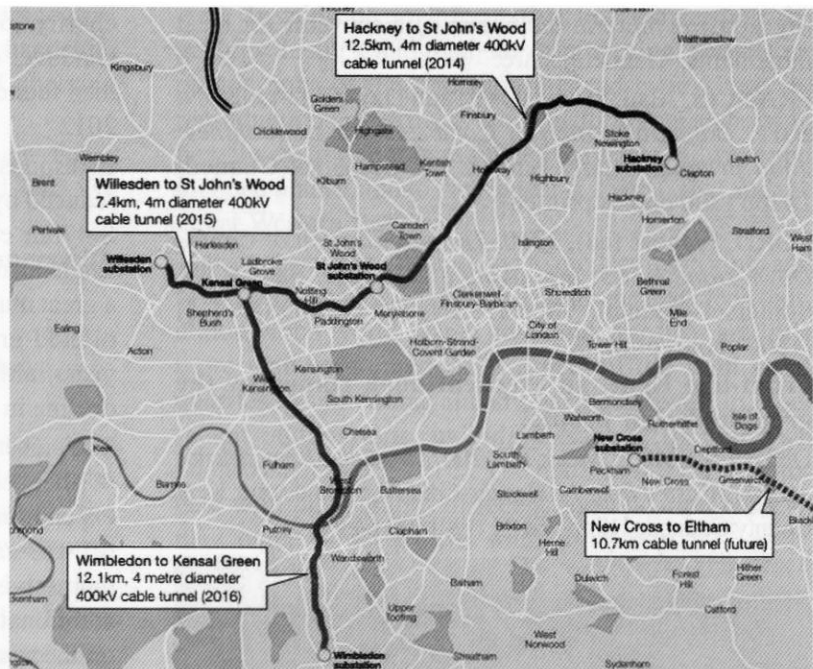
Police said the offenders also made their getaway back down the tunnel. Officers believe the people responsible could have spent up to six months digging the passageway.



The tunnel

This is the second time thieves have attempted to steal this cash machine by the same method. In August 2007 a similar attempt was foiled after workmen found a 40ft tunnel while digging into the ground near the retail park to lay electric cables when they breached the top of the tunnel. This tunnel also started at the railway embankment. A wooden trap door, covered with soil, hid the entrance to the passage, which was only accessible with a ladder. Inside, builders found a wheelbarrow and shovels the would-be thieves used for digging and moving earth.

The tunnel, which was 20ft short of its target, had electric lighting and scaffolding support. It was later filled with concrete. SOURCE: BBC News – Manchester, 14 January 2012 and 28 August 2007



### Steam train returns to Baker Street, London

The first part of the world's first underground railway, a cut-and-cover job forming part of what is now the Circle Line between Paddington, King's Cross and Farringdon, opened to traffic in 1863. As a part of the 150th anniversary celebrations in 2013, a steam-hauled train is to be run along that stretch of line. There was a trial run after the last public service trains one night in February last.

### Western Central District Post Office, London

The former Western Central District Post Office, a very large building bounded by High Holborn, Museum Street and New Oxford Street, has been out of use by the Royal Mail for some years. Since then, the eight or nine floors have been used for miscellaneous purposes including storage and exhibitions. It is now becoming derelict and vandalised. It is of interest to members of Subterranea Britannica in that it connected below ground to one of the stations on the now closed Post Office Railway.

SOURCE: ANON, 2011, Two Government buildings. *Industrial Archaeology News* 159, 17–18.

### Second boring machine arrives for National Grid's London Power Tunnels project

National Grid's flagship London Power Tunnels project is gathering momentum with the arrival of the scheme's second Tunnel Boring Machine (TBM). The state-of-the-art machine arrived at National Grid's Channel Gate Road site near Willesden Junction in early January.

The machine will be used to tunnel 19 kilometres of the 32km subterranean electricity superhighway which National Grid is carving out deep below London's busy streets.

Named *Evelyn*, the TBM joins the project's original TBM *Cleopatra* which began tunnelling last autumn. The machines are digging along a pre-determined route which will link up National Grid's existing substations at Hackney, St John's Wood, Willesden and Wimbledon.

The TBMs use large concrete segments to line the tunnels as they progress through the ground. Once tunnelling concludes, high-voltage electricity cables will be installed and it is anticipated that the tunnel will be fully operational by 2018.

National Grid Project Manager Gareth Burden said: "London Power Tunnels is one of the most exciting engineering projects happening in the world today. It will play a vital role in keeping Londoners connected to the energy they use. Our work will help ensure London has the power infrastructure to support it as a world class leader in business, commerce, sport and tourism, both now and into the future." He added: "By housing the cables in deep underground tunnels we are avoiding major traffic disruption as we won't need to dig up London's roads either during tunnel construction or for subsequent infrastructure work." For more information: <http://londonpowertunnels.com/index.html>

### New sub-surface ticket hall and an additional 300 metres of tunnels at King's Cross St Pancras LU Station, London

London Underground's King's Cross St Pancras station, serving the two mainline termini, has platforms on the Circle, Hammersmith & City and Metropolitan cut-and-cover lines, and on the deep-level Northern, Piccadilly and Victoria lines. A major upgrade to the station was completed in 2010, doubling its capacity, with a third (northern) subsurface ticket hall, step-free access to all platforms on all six lines, and an additional 300 metres of access tunnels. Excavations between the mainline were up to 21 metres deep. The report has an interesting plan of all tunnels in the complex.

SOURCE: EVANS, Peter, John TURZYNSKI, Robert OAG, and Andy SINDLE, 2011, Super subterranean hub: updating King's Cross St Pancras. *Civil Engineering (Proceedings Institution of Civil Engineers)* 164(2), 73–80, and discussion in 164(3), page 105.

### **New tunnelling proposed at LUL Bank station, London**

London Underground is planning to apply for an Order under the Transport & Works Act for additional tunnelling at Bank station which, at present, sees around 96,000 passengers each weekday, of whom about 40,000 change lines. The proposal is expected to be submitted late in 2012, with provision for a new southbound station tunnel on the Northern Line, and the existing southbound tunnel used to create additional subsurface circulation space at platform level.

Additional connecting passages and escalators to the Central Line and Docklands Light Railway platforms are also envisaged. If approved, work would probably start in 2015, with completion in 2021.

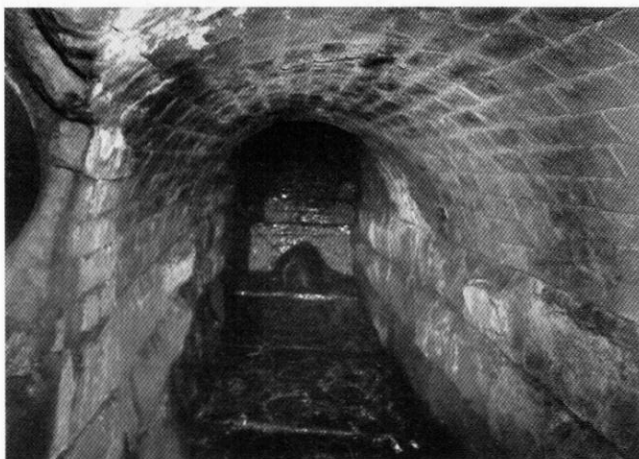
SOURCE: ANON, 2011, New station tunnel for Bank. *Modern Railways* 68(759), page 10.

### **'Tunnel of love' sewer discovered under streets of Blackburn, Lancs**

It's a Valentine's Day venue that could leave amorous couples smelling of more than just roses. A Victorian-era 'tunnel of love' has been uncovered deep beneath the streets of Blackburn town centre.

The tunnel – a brick-lined sewer from Lancashire's industrial heyday – bears a resemblance to the romantic funfair ride, right down to the wooden rowing boat that brave souls must use to explore its twists and turns.

The tunnel has been sealed below ground for decades, but now engineers from United Utilities have begun inspecting it, as part of a major makeover for the town's sewers. The structure, 10m below Dickens Street, has been dubbed the 'tunnel of love' by successive generations of engineers, due to its unusual shape and mode of access.



The tunnel of love

Like their Victorian ancestors, engineers are using rowing boats to explore the tunnel, as motorised vessels risk sparking an explosion in the methane-filled interior.

Carly Atherton, United Utilities project manager said: "It's an amazing structure. When you are sat in one of our wooden boats, merrily floating downstream, you could be forgiven for thinking you are on the tunnel of love

ride at Blackpool pleasure beach. The only giveaway is the rather pungent smell.

"The tunnel was built in the nineteenth century to collect surface water from Blackburn's textile mills, and it still keeps parts of the town centre drained to this day. We're inspecting the tunnel as part of a wider sewer programme for the town, to tackle river pollution. It's certainly one of the more unusual tunnels we have uncovered during the scheme."

Engineers believe the tunnel needs to be protected from cross-contamination by an old Victorian foul-water sewer which runs directly above it. They plan to replace the foul-water sewer, to ensure flows from the tunnel of love run clean once more.

The work is part of a £35m overhaul of Blackburn's sewer network. Engineers are working across the town to increase the size of the sewers, to prevent sewer spills from polluting the River Darwen, River Blakewater and the Leeds-Liverpool canal.

SOURCE: *Burnley Express*, 13 February 2012

### **Upgrading of two tunnels on the M25 completed, Essex**

There are two tunnels on the M25, the Holmesdale tunnel west of Waltham Abbey, and the Bell Common tunnel between Waltham Abbey and Epping (the Dartford tunnel under the Thames is not part of the M25 as strictly defined). Both opened in 1984 and have now been upgraded to meet new European Directive standards.

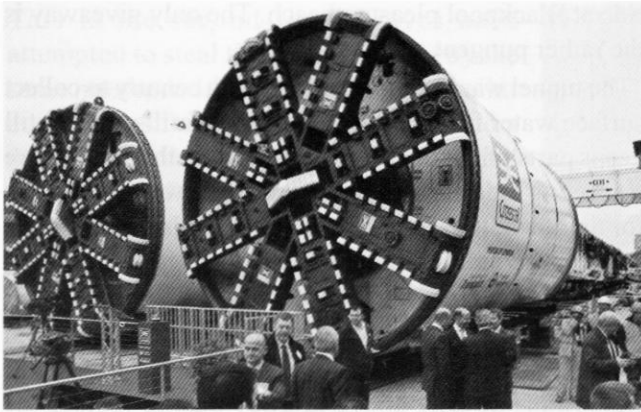
Holmesdale tunnel was refurbished in 2005–2007, and work at the 500-metre Bell Common tunnel has now also been completed. Both tunnels were built as environmental protection measures, as the motorway would otherwise have severed links within communities. That at Bell Common has a cricket ground on its roof.

SOURCE: TOMKINS, John, 2011, M25 Bell Common tunnel refurbishment: faster, leaner, safer. *Civil Engineering (Proceedings Institution of Civil Engineers)* 164(2), 88–95, and discussion in 164(3), 106–107.

### **First of eight Crossrail tunnel-boring machines has arrived in London**

Altogether eight tunnel-boring machines (TBMs) are scheduled to drive London's new twin-bore Crossrail tunnels. Shipped in parts from Germany, the first is now being reassembled at Westbourne Park.

Tunnelling eastwards from the already constructed Royal Oak portal is expected at the time of writing (February) to commence in March 2012; Drive 1 (6.16 km) is from Royal Oak to Farringdon. A second (8.30 km) is from the Limmo Peninsula on the Thames to Farringdon. A branch from Puddingmill Lane to Stepney Green (2.72 km) serves the line to go to Stratford. Another from Limmo to Victoria Dock (0.93 km) is to take the lines to a new Thames Tunnel portal, beyond which there is to be a final drive (2.64 km) from North Woolwich to Plumstead.



The first Crossrail tunnel-boring machines

Work on several new sub-surface stations is already under way. The 21 route kilometres of tunnelling (42 track kilometres) are expected to be completed in 2014. Running tunnels are of 6.2 metres diameter. The latest Thames tunnel (there's already something like a couple of dozen Thames tunnels already, starting with the Brunels' original one from Rotherhithe to Wapping) will be especially challenging work through waterlogged soft ground and flinty chalk.

Three temporary factories are to be erected to manufacture the concrete tunnel-lining segments, at Old Oak Common, Chatham, and a site yet to be designated. Spoil will be removed by various routes and transport modes to Wallasea Island to improve the Royal Society for the Protection of Birds' nature reserve.

SOURCE: HARVEY, Dan, 2012, TBM arrives in London. *Modern Railways* 60(761), page 98.

### Woolwich Foot Tunnel reopens, east London

The Woolwich Foot Tunnel has reopened after £11.5m work to bring the structure up to date. New lifts, stairs, lighting and CCTV have been installed in the Victorian structure, while the tunnel itself has been refurbished.

It follows the recent refurbishment of the nearby Greenwich Foot Tunnel, also in southeast London. Greenwich Council thanked cyclists and pedestrians for their patience while works were ongoing. Between them the tunnels are used for 1.5m journeys a year.



This section of the Woolwich foot tunnel was repaired during WWII. Photo Mike Peel

SOURCE: *BBC News – London*, 21 December 2011

### New legging record for the Standedge canal tunnel, Lancashire / Yorkshire

Members of the Horseboating Society set a new record for 'legging' a boat through the Standedge canal tunnel, over three miles long, between Diggle (Lancashire) and Marsden (Yorkshire).

On 1 August 2011 they took a boat through, a distance of 5,500 yards, by lying on their backs and 'walking' along the tunnel walls or ceiling, taking just under two hours (half an hour shorter than the previous record). Three men did the legging, one to each wall and one to the tunnel ceiling. The team of three was decided upon because of the variations in internal dimensions of the tunnel: in places one or the other wall, or the ceiling, is too far away to be reached.



Legging through the Standedge tunnel

Subterranea Britannica members enjoyed a short canal-boat trip into the Marsden end of the tunnel during the 2011 Study Weekend, as well as a walk through the two older railway tunnels which interconnect with the canal tunnel, with each other, and with the third railway tunnel which is still in use.

SOURCE: ANON, 2011, New legging record for Standedge. *Waterways World*, October 2011, page 41.

### World's first underground cricket match abandoned due to snow, Honister, Cumbria

A planned underground cricket match in a slate cavern 600 metres (2,000 feet) above sea level at Honister, Cumbria, was called off because of snow. Presumably this made getting up the road to the Honister Pass problematic, rather than covering the pitch.

SOURCE: ANON, 2011, The world's first underground cricket match ... *Metro*, 14 December 2010, page 6.

### Another bit of Williamson's tunnels comes to light in Liverpool

A subsidence in rail sidings at Liverpool (presumably in the Edge Hill area) has proved on inspection to be a collapse into a rock-cut tunnel a metre wide and two metres high, blocked at both ends by rubble. It is thought that this may be one of the tunnels dug locally in the early part of the nineteenth century by the eccentric Joseph Williamson. The cavity has been filled with foamed concrete.

SOURCE: ANON, 2011, Labyrinth under Liverpool. *Modern Railways* 69(760), page 30.

### **Third modernisation of the world's third underground railway, Glasgow**

The Glasgow Subway is now 115 years old, and third amongst the world's sub-surface urban railways after London (1863) and Budapest (1896). It is a simple pair of tracks running in tunnel in a continuous loop under the city, with trains running clockwise on one track, and anti-clockwise on the other. Trains pass under the Clyde twice in each circuit.

Unusually, the system has never been extended, and (also unusually) remains in public ownership. At first the trains were hauled around by cables worked from a single engine-house, but they have been electrified since 1935. The line is of about six and a half route miles, and the tracks of four-foot gauge run through eleven-foot-diameter tunnels of (other than under the river) cut-and-cover construction. So it is rather less spacious, even than the Northern line in London!

A second modernisation followed in the 1970s, when the line came to be known as the Clockwork Orange, and a third is about to commence with, probably, automatically operated trains. There are no junctions or branch lines to complicate matters, other than sidings into the depot for servicing and stabling overnight. Other aspects of the imminent modernisation are the upgrading of the tunnels, drainage, permanent way, and power supply. All fifteen stations are to be revamped, and escalators installed.

SOURCE: ABBOTT, James, 2012, Clockwork Orange to go digital. *Modern Railways* 69(761), 66 - 67.

### **Metro Line 1 to go automatic, Paris, France**

Driverless trains are to be brought into use on the 16.6 km Paris RATP Metro Line 1. This is the oldest of the Paris Metro lines, having commenced operation in 1900. It is the busiest line, carrying 725,000 passengers per day. Platform-edge doors (as on our own London Jubilee Line Extension) are to be installed at all stations on Line 1.

SOURCE: ANON, 2012, Paris Metro Line 1 goes automatic. *Modern Railways* 69(761), page 81.

### **Increased traffic on the world's shortest railway, Vatican City, Italy**



The headshunt tunnel at the end of Vatican City station platform

The 300 metres of double-track Vatican Railway and its single terminus station is almost entirely open to the sky and indeed is in part on a viaduct. However, beyond the single terminal station the line runs into a short 'headshunt tunnel' thus qualifying for a mention in *Subterranea!*

The Stato della Città del Vaticano (Vatican City) was established as a separate state in 1929 and has an area of 109 acres (0.17 square miles) and a population of 805. Its railway is a short spur from the Italian state railway network, used mostly for goods traffic. There are no regular scheduled passenger services. All good stuff for a pub quiz?

The terminus has a single passenger platform, serving one of the two tracks. It has reportedly been more than usually busy in the last year: the Vatican even issued a press release. Pope Benedict XVI took a passenger train on 27 October 2010 for a visit to Assisi. A special passenger train ran in May 2011 in connection with raising funds for victims of an Italian earthquake. And an Italian train included the spur as part of a training run.

SOURCE: ANON, 2011, Record year for the Vatican Railway. *Modern Railways* 68(759), page 84.

### **Drug smuggling tunnels under the border, Mexico / USA**

The latest of around seventy drug-smugglers' tunnels discovered under the border between Mexico and California, USA, has been declared the most sophisticated. From Tijuana (Mexico) it runs underground 2,600 feet (almost half a mile) towards San Diego on the California coast. The tunnel, complete with a narrow-gauge railway, runs from one warehouse to another, and is equipped with lighting, ventilation, and a lift.

SOURCE: ANON, 2011, Tunnel of drugs: rail link to US. *London Evening Standard*, 30 November 2011, page 26.

### **Supersewers at Milwaukee (USA) and London**

London's intended deep-level sewer running, to a considerable extent, below the bed of the River Thames has attracted some opposition, largely on account of the proposed siting of tunnel spoil extraction sites in public open spaces.

The 'antis' can now cite Milwaukee's experience with such a sewer in support of their arguments. The US city's sewer (which cost \$1.2 bn) has reduced the volume of untreated sewage discharged to its main river by 85 percent. However, there have been complaints of flooded basements and sewage overflows.

In October 2011 proposals for a shorter London supersewer were put as an alternative to the £3.6 bn Thames Water plan, which it was felt might save some districts from being blighted as construction sites for at least seven years. A report commissioned by Hammersmith & Fulham Council suggests a shorter and cheaper sewer.

SOURCE: *London Evening Standard*, 31 October 2011, page 8., 3 August 2011, page 18.

## Visits to Tessin and Prora, Germany

In September 2011, a group of Sub Brit members made a private visit to various military sites in Germany. Three members of the group provide an account of their visit, including significant historical background information.

In Part 1, we start with Chris Howells' description of the former *Volksmarine* bunker in **Tessin**. This is followed by a write-up of **Prora** by Tony Page and Adrian Trice.

In Part 2, in the next edition of *Subterranea*, Tony and Adrian continue the write-up of the visit to **Peenemünde**.

### Tessin former Command Bunker – Introduction

After World War II ended two German states emerged. East Germany (*Deutsche Demokratische Republik* or *DDR*) occupied approximately one quarter of the land area and was located to the northeast. West Germany (*Bundesrepublik Deutschland* or *BRD*) occupied the remainder. The *Volksmarine* (East German Navy) was the facet of the *Nationale Volksarmee* (NVA or National People's Army) responsible for protecting East Germany from the sea. Being behind the Iron Curtain of the East, this meant keeping people in as well as out.

The former command bunker of the *Volksmarine* at Tessin is situated in today's northern German *Land* (state) of Mecklenburg-Vorpommern. The bunker was built to be the main command post – the *Hauptgefechtsstand* – of the *Volksmarine*. In the event of war, the staff of the *Kommandos der Volksmarine* (Commanders of the Navy) – normally based in nearby Rostock – would be sent to the bunker to take control of the situation.

However, to some in the *Volksmarine* a land-based *Hauptgefechtsstand* was a strange concept – would not a ship-based *Hauptgefechtsstand* be a more compelling prospect? Imminently more manoeuvrable and familiar to sailors than a bunker built on land, albeit perhaps slightly more conspicuous ...

The area around Tessin was the only part of East Germany to be located on the sea – so it was an important area for the *Volksmarine*. The other part of today's Germany with a sea border is the *Land* of Schleswig-Holstein – located in the west.

The bunker at Tessin was designated as *Objekt 16/001*; it is situated in a forest, just off a minor road between the small towns of Tessin and Laage. Tessin is approximately twenty miles from the Baltic coast and approximately 140 miles from Berlin. Although not as large or sophisticated as the perhaps best-known East German bunker, *Objekt 17/5001* – which was Erich Honecker's bunker (visited by Sub Brit members a few years ago), the *Volksmarine* bunker at Tessin is surprisingly large, with two floors, each with a dimensions of 49.3 x 57.5 metres, giving a usable floor space of 2,961 m<sup>2</sup>.

### Design of the Tessin bunker

Construction started in 1968, and the bunker was in operation by the middle of the 1974. It was built to the specifications of *Schutzklasse A* (protection class A) at a cost of 100 Million Deutschmarks, a tremendous sum of money. *Schutzklasse A* was the highest level of

protection that East German bunkers were built to, reflecting its sensitive and important nature. *Schutzklasse A* required the bunker to be capable of withstanding overpressure from a nuclear blast of 25 kp/cm<sup>2</sup> or a conventional concrete penetrating bomb of more than 2,500 kg. Only two types of this particular design of bunker were built in East Germany, the other being *Objekt 16/017* at Hennickendorf.

The bunker could operate in three modes of operation:

Regime 1 – normal ventilation – approximately 10–15 percent more fresh air is taken in than exhausted to maintain the overpressure in the bunker;

Regime 2 – protective ventilation – the bunker is hermetically divided into two areas, an inactive clean zone and an active contaminated zone. Radiological and chemical filters clean and filter the air;

Regime 3 – lockdown – when the level of impurities in the outside area exceeds a threshold, no air is taken from outside; the air is purely recirculated inside the bunker.

A staff of approximately seventy persons were employed continuously at Tessin to keep the bunker maintained in a constant state of readiness. In the event of war, the staffing level would increase by about 150 persons – with a total capacity of 300 persons.

As is typical with East German military facilities, to secure the facility there was a 17,000 volt electric fence around the perimeter. The total land area used by the bunker and its support facilities amounted to 115 hectares (1,150,000 m<sup>2</sup>).

### Structure of the bunker – and final days

The lower floor mainly consists of infrastructure including the diesel generators, diesel fuel tanks, air conditioning equipment, kitchen and canteen, telephone exchange, battery rooms, and the main bunker control and dispatch room. Meanwhile, on the upper floor there is a small amount of living accommodation for the more senior members of staff such as the *Kommandant* (commander), and a number of operations rooms containing facilities for displaying maps. Spanning both floors was also a *Rohrpost* (pneumatic mail) to deliver messages around the facility.

Unfortunately for the bunker there were problems with water ingress fairly early on; in the second half of 1976 remedial work was undertaken to attempt to alleviate these problems. This was only partially successful and more remedial work was undertaken from 1984 to 1986.

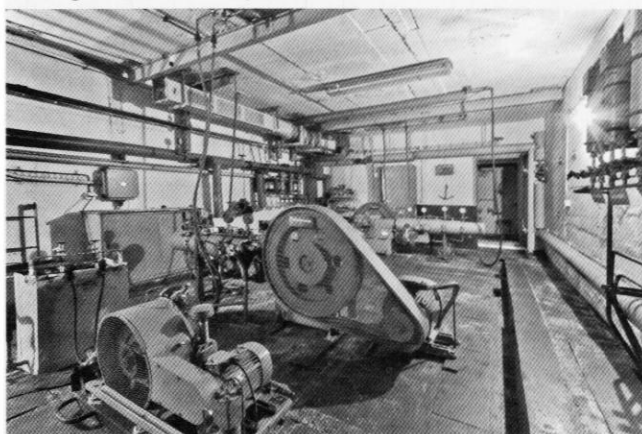
In the middle of the 1980s, with technology progressing, it was envisaged that the *Hauptgefechtsstand* (Command Post) would need to grow in order to facilitate the further needs of the *Volksmarine*. The existing bunker was considered to provide insufficient facilities for expansion, so the expansion would have consisted of a considerable amount of construction work, designated *Objekt 17/8817*.

The work had been planned for 1990–94, although the fall of the Berlin Wall due to the peaceful revolution in East Germany in 1989, followed by the reunification of the two German states in 1990, obviously put a stop to these plans. The bunker was then finally sealed by the new armed forces, the *Bundeswehr*, of the reunified nation in 1993.

### Sub Brit visit to the Tessin Command Post Bunker

In 2011, for the first time in nearly twenty years the bunker was accessible again – on 8 July at 23:43hrs the final bit of concrete was removed from the former main entrance of the bunker. Claus Funke negotiated with the landowners to make the bunker accessible to paying members of the public for a period of three months. The bunker is now sealed again.

We were lucky enough to be able to visit every corner of the bunker at our leisure, taking photos, and looking in every nook and cranny, as is typical with Subbrit visits. I actually spent three days in the bunker in total – spending about one and a half days taking photos, and the remainder of the time exploring. Although I very much enjoy the challenge of taking good photos underground, the time taken to set up a camera, tripod and lighting can considerably eat into the available exploring time! Despite spending three days at the bunker there are still things that with hindsight I have missed, despite originally thinking after leaving for the final time that I had actually managed to see every room.



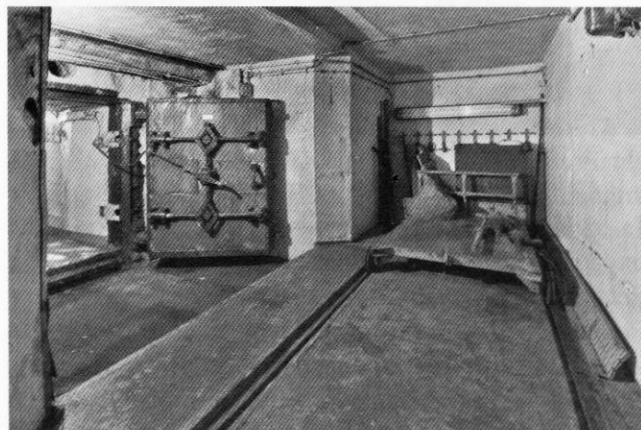
The air compressor plant room. The floor of this room is spring-mounted, and most equipment is mounted onto this. As well as the actual sub-surface construction, the bunker was supported by a variety of surface facilities. This included two accommodation buildings, two emergency exits, vehicle garages, radio aerials, as well as several chimneys to support the four diesel generators. The

accommodation buildings consist of three storeys plus a basement. There is no subterranean connection between these buildings and the bunker.

### Exploring Tessin

Driving onto the site today, the original guard house is evident on the right. A long concrete path connects the road to the bunker site. The bunker is in really rather good condition today. There has been very minimal water ingress since sealing. On the lower floor there is at most a very light covering of moisture on the floors and there is a small amount of mould in certain areas. The earlier remediation work to prevent water ingress was clearly successful at preserving the bunker.

Down from the original main entrance to the bunker there is a considerable flight of stairs. The bunker entrance blast door is situated to the left. The main way to get equipment into the bunker appears to have been via a trolley mounted on rails either side of the steps, which would have been moved by a winch. Just in front of the blast doors is one of these trolleys – perhaps the only one. After stepping through the blast door the usual bunker aroma is noticeable. Hard to explain – slightly musty, but very pleasant. After the multiple blast doors, the bunker continues to the right.



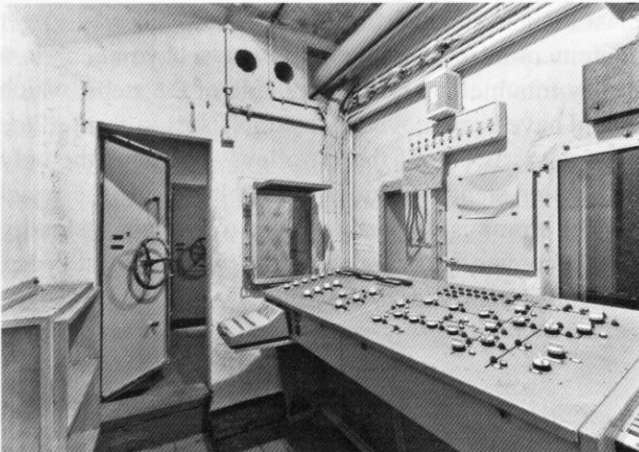
At the bottom of the stairs, around the dogleg, is the main blast door to the left and one of the trolleys that would have been winched up and down the stairs to provide supplies to the bunker

To the left is the decontamination facility consisting of showers and a control panel behind a glass viewing area. To the right of this a fairly large quantity of air-filtration equipment is installed consisting of large metal Soviet canisters with Cyrillic writing on them. A corridor leads off into the distance – further down it splits to the left and right. Upstairs are a number of corridors, with rooms leading off.

There are two sets of stairs to the lower level, and the two emergency exits are situated at opposite ends of the bunker, with a similar arrangement of corridors. Overall a large amount of equipment in the bunker is mounted on springs including the floors of several rooms, the main electrical supply equipment, and a number of air compressors.

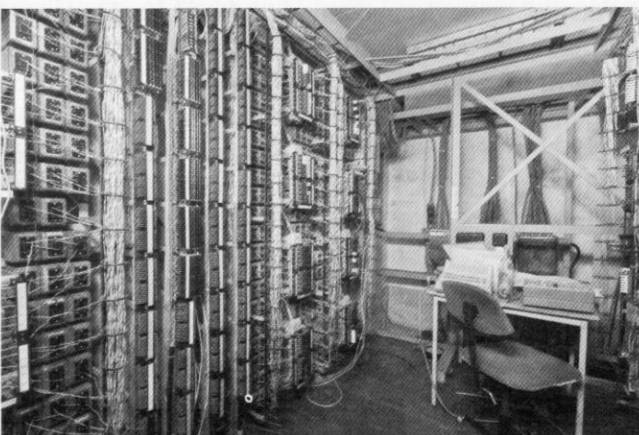


Upstairs, the corridor splits to the left and to the right leading to additional rooms. An alarm klaxon is on the wall in the middle of the picture



The control panel in the decontamination area, with a glass viewing area

In lockdown mode the levels of carbon dioxide and oxygen in the bunker would have been closely monitored. Scattered occasionally around the bunker are large yellow Soviet oxygen generators. In the event of oxygen levels in the bunker falling to unacceptably low levels, these would have been activated, absorbing carbon dioxide and emitting oxygen through an exothermic chemical reaction. It was also delightful to see a bunker with so many fixtures and fittings still intact. All four diesel generators are still in place – most unusually. This is presumably to do with

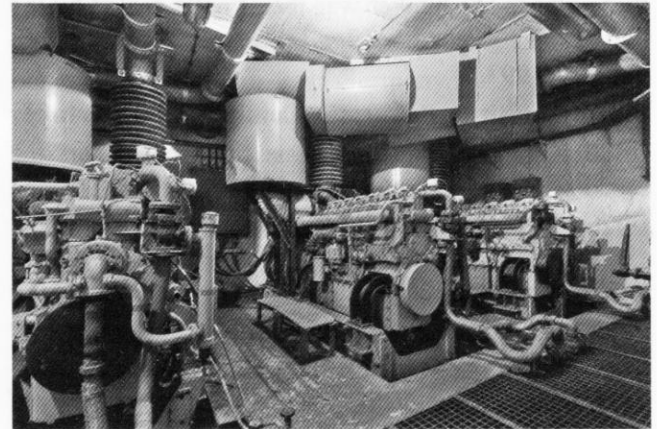


The telephone exchange situated on a fairly small room, with two racks, one on each side. On the table were a variety of original plans

the fact that there is no evidence of there being an equipment shaft, so removing them would have been difficult.

### Equipment in the bunker

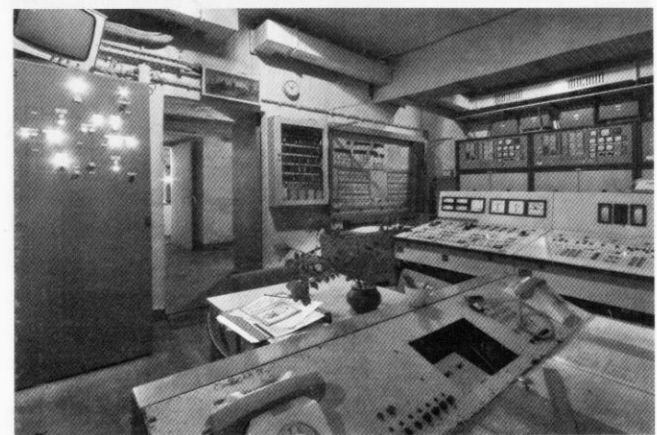
The bunker-openers have clearly been very busy attempting to rejuvenate old equipment. On my second visit, about three weeks after the first, one of the diesel generators was in a state where it could be run to demonstrate to visitors. Not surprisingly, after sitting for twenty years, it didn't sound completely silky smooth, but it certainly generated quite some excitement to see it going again.



The bunker had four diesel generators to provide emergency power – the fourth being situated to the left of these three

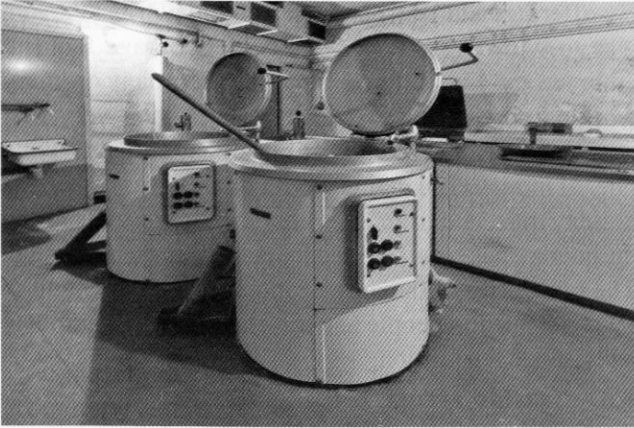
On the opposite side of the corridor from the generators are the diesel tanks. Like a good amount of equipment in this bunker, they are mounted on four springs, each spring being approximately the same size as a spring in a car's suspension. The tanks themselves are connected to the bunker using flexible hoses, so they were well designed to cope with shocks resulting from any nearby blasts.

Next to the generators is the dispatch room, containing the main control panels for the various facilities of the bunker such as ventilation and power. There are two main control desks, consisting of switches, meters and indicating lights. Around the room are more control panels for various types of equipment mounted on the walls.



The heart of the bunker, the dispatch room. From here, key functionality would be controlled such as the ventilation and electrical systems

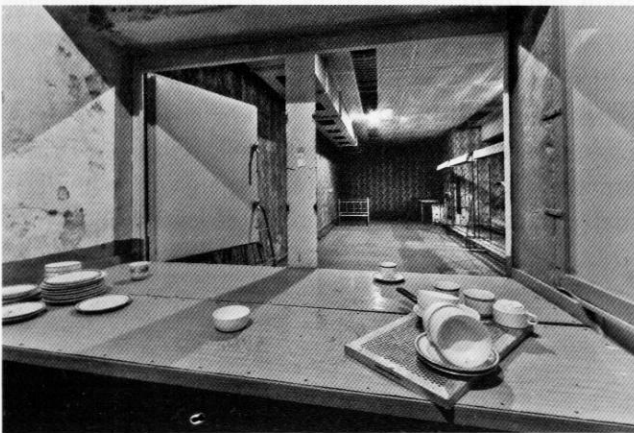




Sizeable cooking instruments in the kitchen were required to feed the several hundred staff that could spend a time locked in the bunker in the event of war

It was a nice touch to see an original CRT television mounted on the wall, up high near the entrance door. The bunker staff had also connected a number of control-panel lights to an electricity supply to illuminate them, to give an illustration of how the panels might look if all of the bunker's facilities were operational. A rather nice touch – even if what was displayed was totally meaningless.

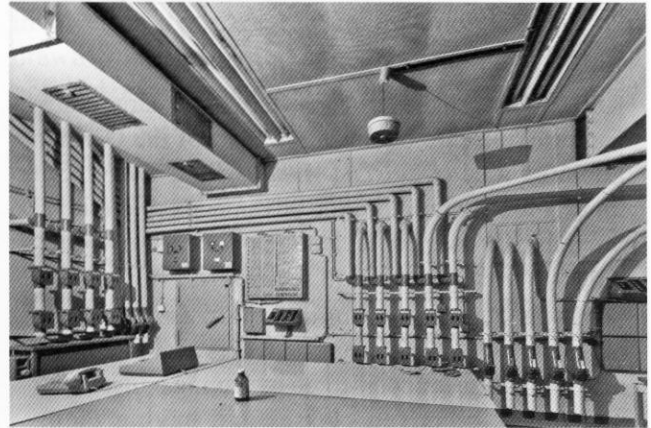
Opposite the dispatch room is the kitchen and canteen. These look like they were abandoned yesterday, with frying pans still left on the cookers and stirring ladles in the extremely large saucepans. An ample supply of clean crockery is stored next door by the serving hatch. On my first visit, the *Rohrpost* message delivery system was demonstrated to us and like excited children we were able to send messages from one room to another. Like so many other things in the bunker, the original electrical motor was still in working condition.



The serving hatch adjoining the kitchen, looking into the dining area. Dining times would presumably have been staggered, hence the fairly small dining area

Although they are still intact, the accommodation surface buildings are in very poor condition, with almost all equipment removed or vandalised. The emergency exit shaft is an interesting dome-shaped concrete construction, presumably designed to deflect any blast wave.

Nearby to one of the emergency exits is the cable exit passage for the bunker, protected with a blast door.



The *Rohrpost* communication system was used to send messages to rooms all over the bunker –

The sign in the middle of the picture says *Verbindungs Uebersicht* – or connections overview

Although a good amount of concrete had been poured in front of the blast door to prevent it from opening, a hole large enough to climb through had been cut in the door allowing access. Inside is a simple and fairly short corridor leading to a vertical shaft and ladder which goes down to the cable exit routes on the bottom floor of the bunker.

#### References for Tessin:

<http://www.bunker-tessin.de> (in German).

*Geheime Bunkeranlagen der DDR* - Stefan Best - page 136 onwards (in German).

*Programm Delphin Atombunker Kalter Krieg* - Paul Bergner - page 391 onwards (in German).

*Die Militärische Sicherheit der DDR im Kalten Krieg* - Hans-Werner Deim, Hans Georg Kampe, Joachim Kampe, Wolfgang Schubert - page 128 onwards and page 225 onwards (in German).

<http://www.spiegel.de/international/germany/0,1518,782755,00.html> - article in *Der Spiegel* magazine (in English).

#### Visit to Prora

*The Sub Brit* group then moved on to visit Prora, on the Baltic Sea island of Rügen. Tony Page describes the history of the complex, followed by a visit report by Adrian Trice.

#### Prora: KdF resort by the sea

Originally built as the world's biggest hotel, stretching along 4.5 km (3 miles) of one of Germany's best beaches with 10,000 rooms, the building was never used as a holiday resort for the masses in WWII or afterwards, although it was used by the military.

As part of the Nazi 'Strength through Joy' program (see panel), the resort's aim was to prepare up to 20,000 citizens for war through organised leisure. The outbreak of war put an abrupt end to its construction in 1939, yet even in its incomplete version it was one of the biggest Nazi building projects.

**KdF - Kraft durch Freude  
(‘Strength through Joy’)**

KdF was established as Nazi Germany’s large state-controlled leisure organisation, part of the German Labour Front (*Deutsche Arbeitsfront, DAF*). Set up as a tool to promote the advantages of National Socialism to the people, it soon became the world’s largest tourism operator of the 1930s.

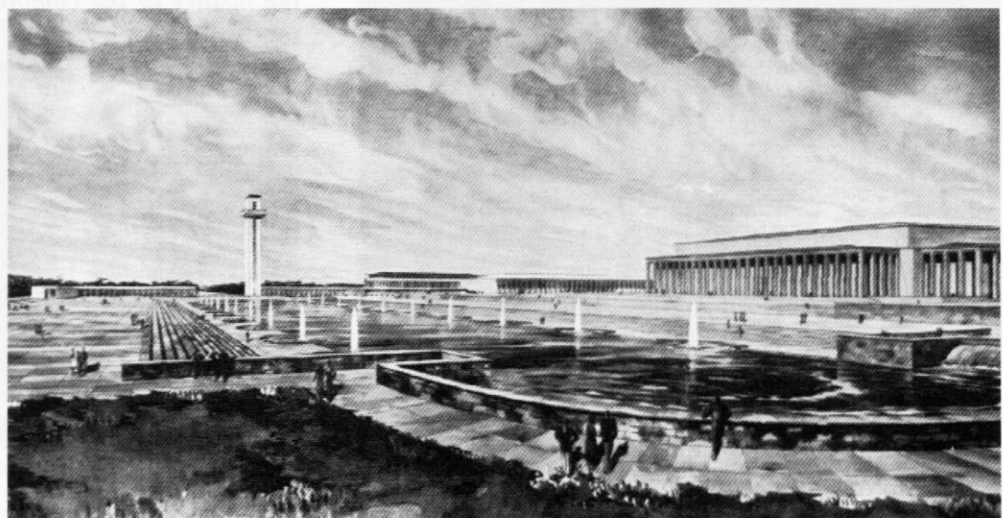
KdF was supposed to bridge the class divide by making middle-class leisure activities available to the masses. This was underscored by having cruises with passengers of mixed classes and having them, regardless of social status, draw lots for allocation of cabins. Another less ideological goal was to boost the German economy by stimulating the tourist industry out of its slump from the 1920s.

**The Nazis use leisure facilities to prepare for war**

In January 1933 the National Socialists (NS), under the leadership of Adolf Hitler, gained government power in Germany. Shortly afterwards, unions were banned and their assets channeled into the newly-founded German Labour Front (*Deutsche Arbeitsfront – DAF*) with Dr Robert Ley as its leader. Ley, a devoted Nazi and Party member since its early days, had been rewarded for his loyalty with the leadership of the German Labour Front on its foundation in May 1933. In November 1933 Ley founded the leisure organisation ‘Strength through Joy’ (*Kraft durch Freude – KdF*), the idea being that German citizens could not only be controlled at work, but in their spare time too.

In their efforts to tame the working class – potentially the largest source of opposition to the regime – the Nazis resorted to tactics of violence and intimidation from early on. It is sometimes forgotten that alongside the frequently wielded stick, the carrot was more sparingly deployed. It was dangled before the eyes of the German workers in the hope that they would find fitting reward for their political acquiescence, and their toil in the service of the Fatherland.

An artist’s impression of the completed complex shows the festival square and the assembly hall, which was never started. Visitors arrived by ship at the quay and proceeded to one of two reception halls (colonnade in the centre distance) to be assigned to rooms. The complex was so large that a miniature railway would have carried holidaymakers to the more distant housing blocks



By offering paid leave and cheap holiday trips, the aim was to win over the workers and encourage them to embrace and live for the NS regime. For many ordinary working people, this would have been their very first opportunity ever to actually go on holiday without having pots of money. The main activity of KdF was organized holiday trips, and from 1934 chartered trains transported the holidaymakers off around the country to their vacation. The popularity of the organization grew quickly and in 1934 2.3 million people had travelled; by 1938 numbers had risen to ten million.

**KdF Seaside resorts**

To further win over the workers to the NS regime, in July 1935 KdF announced plans to build five giant seaside resorts on the German coast. Of the five planned, only one was started – on the east coast of the Baltic Sea island of Rügen, along the beach at Prora. The Nazis planned mass murder and they also planned mass tourism, as part of their attempt to indoctrinate the entire German population.

The building complex at Prora extended to 4.5kms (3 miles) in length, was six storeys (20m) high and was right on the perfect beach. Capable of accommodating 20,000 people at once, it was truly massive.

Having the infrastructure of a city, KdF Seaside Resort Rügen had its own electrical substation, railway station, waterworks, hospital, kindergarten, cinema, school, car park, bakery, butchers, laundry, post office, cafés, restaurants and a shopping mall. A bridge from the mainland to Rügen was completed in October 1936.

Two modern swimming pools with sea water and wave machines were planned and in the centre of the complex was to be a huge Celebration Square complete with water pools and fountains close to a large quay with moorings for the KdF cruise ships *Robert Ley* and *Wilhelm Gustloff*.

**Design of facilities at Prora**

Ley envisioned Prora as a parallel to Butlins – the British ‘holiday camps’ designed to provide affordable holidays for the average worker. Designed by Clemens Klotz (one

of Adolf Hitler's architects), all rooms – of which there would be 9,847, all identical at precisely 2.5 by 5 metres – had a view of the sea a mere 90 metres away.

Furnishings, too, were to be identical: two beds, a sofa, a table and chairs. There was to be a built-in basin with hot and cold running water, as well as built-in wardrobes – quite modest by today's standards, but revolutionary in the context of their time. Bathrooms and toilets were located in the staircases buttressing the buildings on their inland side.

Dividing the accommodation blocks were 'community halls', three storeys high and jutting out towards the sea. They were to contain restaurants and kitchens as well as covered terraces with a direct view of the beach. Connecting all of these structures was a promenade running the full 4.5 km length of the development, which, like the buildings, followed the gentle curve of the bay on which it was located.

There were also plans for a huge 'Festival' hall capable of holding all of the 20,000 holidaymakers but this idea was shelved at an early stage due to financial constraints. This hall was to be the jewel in Prora's crown – the one building on the site that was not the work of Klotz, but of his rival Erich zu

Putlitz. The latter's involvement, albeit only at the planning stage, was due to the direct intervention of Hitler, who presumably found Klotz's plans for a central hall inappropriately modest. The zu Putlitz design, had it been realised, would have provided easily the most pompous of Prora's buildings, large enough to accommodate all 20,000 guests at once for special occasions.

'Seaside Resort Rügen' (Prora) offered the fully inclusive holiday, and all for a paltry two reichmarks a day. According to the promo, all the punter needed to bring was his or her clothes, pyjamas, comb, toothbrush and a flask. Everything else was provided by the resort – food, drink, beachwear, towels, soap, dressing gown etc. You even got a special 'beach suit' in case of rain. Utilities – linen, crockery and beach utensils – were designed specially for the resort.

### Construction of the resort

By the time the model for the site went on display at the World Fair in Paris in 1937, construction work on Rügen was well under way. Using some personal contacts, Ley had been able to acquire an appropriate, substantial piece of land in July 1935 and work began on 2 May 1936, three years to the day after the suppression of German trade unions.

The Prora resort had reached various stages of construction when WWII started in September 1939. During these three years, all of the Reich's 48 major construction companies and nearly 9,000 workers were

involved in the project. Many of these workers were drawn from concentration camps, by then filled with political prisoners and anti-Nazis.

In September 1939 construction on Prora stopped, and most of the construction 'workers' were sent to Peenemünde and the Siegfried Line. One witness recalled a wartime visit by an official from Organisation Todt – the special unit set up in 1938 to construct military installations – who told the workers, 'So, gentlemen, that's it for now. Victory will be achieved quickly and then we



Prora under construction in 1937

can continue.' Polish and Russian PoWs were able to complete the task of sealing the roofs, but, by the beginning of 1943, work had ceased entirely.

The eight housing blocks, the theatre and cinema stayed as empty shells, and the swimming pools and festival hall never materialised. Completion had originally been planned for 1941, but the complex was never finished due to the need for construction materials for the war effort. This halted construction on the resort at Prora and it never actually functioned as such.

During the war the unfinished Prora buildings were used for 'war-important purposes' such as a PoW camp, a camp for forced labourers (who had, in fact, built the place initially), a training camp for propaganda and news 'reporters', as a military hospital and, during 1940, more than a thousand police officers – a Battalion – received military training, prior to being sent to the Eastern Front.

The KdF seaside resort at Rügen did not, despite creating jobs, fulfil any of its planned tasks because it was not finished before the war actually started. In addition, refugees from the bombing of Hamburg and other cities lived in the few finished buildings in 1944–45. During the war the complex was also used as a training site for police and female signals auxiliaries.

In spite of this, the Prora resort complex – a three million square metre site – was the largest construction project of the Third Reich that reached this level of completion, and the site remains the largest Third Reich building in existence.

### Prora after the war

After the war the Russians attempted to blow up some of the buildings but this proved a difficult task. Instead, the damaged northern end of the complex was subjected to demolition practice while the rest was occupied by the Soviet military before being stripped of usable materials.



Aerial view of the Prora complex looking north

After 1950 the Russians handed it over to the East German Army (NVA) who used the complex up until 1991. They honed their urban warfare skills in the demolished and semi-demolished northern end, in some cases completing the job started under the Potsdam Agreement.

Throughout the 1950s the NVA rebuilt and completed several of the unfinished buildings to house soldiers, and later as a resort for officers. Since the buildings had been stripped back to bare bricks by the Russians in the later 1940s, most of the exterior and interior finish that can be seen today is East German. And looks it.

### Sub Brit visit to the Prora resort

Our first visit was to the museum building. A scale model of the complex was on display which gave a very good insight into what the finished buildings would have looked like, including a harbour for guests arriving by sea and a giant festival hall which could house all 20,000 people at once.

The museum had many period exhibits including advertising material and brochures for holidays at the resort. The other floors of the museum housed a staggering amount of equipment relating to the East German Army (NVA) occupation of the resort during

the Cold War period. One room contained a computerised tank trainer and another vast array of communications equipment; other rooms had displays of uniforms and insignia as well as flags for different divisions.

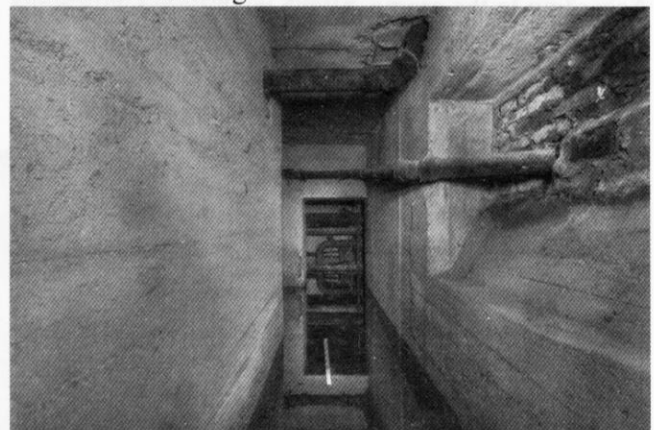


The south end of the Prora complex looking north.

Photo Nick Catford

After leaving the museum we walked along the rear of the buildings – one of which had the rear door hanging off; we quickly made a beeline for the door and entered the building at the foot of one of the staircases. We made our way to the top floor and looked around the floor which was in the early stages of being converted to flats. Piles of plasterboard and blocks were stacked up and the windows had been changed to aluminium double-glazed windows – however, work had stopped some considerable time before and it looked as though the developers had gone bankrupt.

We then entered the next building which was unconverted and probably as it was left after the NVA moved out, albeit rather vandalised in the following years. Remnants of curtains and pelmets were hanging from the windows, and the view along the rear corridor showed the gradual curve of the building.



There is an underground element to Prora with service tunnels beneath the buildings.

Unfortunately those we looked at were flooded and inaccessible

The next building had one of the floors converted into a restaurant complete with a dumb waiter lift – it was unclear when this had taken place – but the internal fit-

out looked very dated, and may have been from the NVA days.

### Outside views of the Prora complex

We then left and continued to the end of the buildings, walking on the seaward side to take in the view of the coast. Each guest would have had a sea-facing room, with the back of the buildings planned to house the dining and bathroom facilities.

We walked along the whole frontage of the buildings, past one that has been converted into a very smart-looking Youth Hostel. This clearly showed that the complex is capable of being refurbished to a high standard if called for. Further along we saw blocks that had been stripped and are in a very poor state of repair; this group of buildings is heavily fenced-off given their dangerous condition.

The gatehouse area had an almost forgotten and overgrown monument to Otto Winzer located nearby. Winzer was an East German diplomat. He returned from exile in the Soviet Union as part of the Ulbricht Group, charged with setting up the Soviet military administration in Germany after WWII. He later served as the foreign minister of East Germany (DDR) between 1965 and 1975.



At the north end of the complex some blocks have been demolished while others have been partly demolished and are now in a dangerous condition

Finally, we looked around the exterior of the Cinema building – once again this was very impressive and has now been converted into a nightclub and bar.

On our way back to the car we ventured up a ladder and onto the roof of one of the buildings. The view was not only amazing but it was a really good vantage point to take in the sheer scale of the structures – they curve away into the distance matching the contour of the bay. After a few more photos from the roof top it was time to leave – it had been a long but very enjoyable day.

New photos by Chris Howells unless stated

---

## Is there or was there a Cold War buffer depot near you?

Paul W. Sowan

Buffer depots were secure warehouses containing basic non-perishable food reserves to sustain such of the population as had survived a nuclear strike to be able to resume their 'normal activities'. They are quite distinctive buildings, appeared in use generally to have no staff, and no displayed identification of ownership or purpose beyond a telephone number and an obscure company name.

Some have been demolished, and others are now in alternative use. There is an example in the north-east



quadrant where the A25 between Dorking and Reigate crosses the B2032, to the south of Betchworth railway station in Surrey.

This is a three-bay assemblage of three parallel red-brick warehouses with sheeted pitched roofs and large sliding doors on the Station Road (B2032) side. It is now in use by a wholesale floristry concern,

# Europe's largest underground oil power-plant

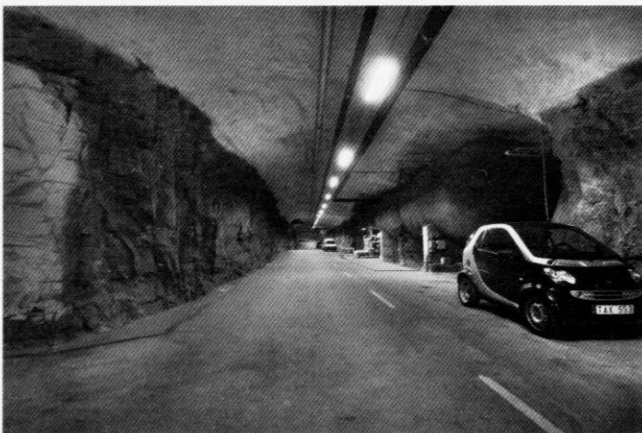
Lars A. Hansson

In 1945, after World War II, there was a demand in Sweden to make secure the production of power to the national grid, especially if there were a new crisis or even another war.

The main idea was to build a new and updated version of the steam power-plant in Västerås, at that time already thirty years old. It had suffered major production problems during the war, especially during the cold winters when its dependency of oil and coal transport on Lake Mälaren was stressed to the limits due to the very cold weather. With these demands and knowledge the plan was to build the new site on the west coast of Sweden and inside a mountain. An underground location was initially considered to give a high degree of protection for all vital parts during a new war. It was not vital to produce power during a new war; what was more important was to be able to start production again as soon as possible afterwards. The west coast location was mostly chosen on account of ice-free harbours and easy access to huge amounts of fresh water to cool the steam turbines.

## Studies for the positioning

The planning was forced at great speed with the demand for six boilers at 50 MW each. The mountain height (amount of rock) above the generator halls should at least be as much as the width of the halls, 53 metres.



Part of the access road network along the back of the site.  
Close to the water treatment plant

Between Alingås and Göteborg, at Stenkullen, preparations were made for a new sub-station to feed the power from the plant out onto the national grid. The placement of the plant was therefore prioritized to the area around the Göta älv river valley or the southern parts of Bohuslän county.

A total of seventeen possible sites were located between 20 and 65 km from Stenkullen, and had mountain coverage of between 51 and 149 metres. Twelve sites was deleted during 1952–53, mainly due to lack of mountain coverage. Five sites were selected for further study:

	height of mountain cover (m)
Dirkhuvud, Ljugskile	73 – 100
Kolhättan, N Stenungsund	80
Hällungen, NO Stenungsund	149
Stenungsund	88
Bolsten, SV Kungälv	111

After more studies three of these sites were deleted due to high construction and operational costs. The two remaining were Stenungsund and Bolsten.

When these two sites were checked in detail, it was found that Stenungsund already had a working harbour for the oil and coal needed. At Bolsten, however, this was not possible due to the situation in the river of Nordre älv and the plan for that site was to build a new harbour further out towards the sea and take the supplies by road the last bit.

## Decision and building

On 25 May 1954 the Swedish parliament took the decision to site the new power plant at Stenungsund. By August 1955 the first detonations could already be heard from the rock blasting.



One of the two control rooms, controlling generators 1 and 2 which are the older pair. The control room is sited between the two generator halls.

This was incredibly fast to make plans and drawings of everything that should be included in the mountain. Not only was there the power plant itself, but also oil storage capacity, an internal water-treatment plant, and a conveyer system to the harbour were all built at the same time.

Work started on three different fronts with a total of five hundred men. After 1½ years of blasting and taking out 1 500 000 m<sup>3</sup> of rock, the blasting was finished and concrete work took over. A double tunnel was blasted from the sea into the site to be able to cool engines and generators producing up to 900 MW. Each tunnel was 2600 metres long with a cross-section of 40 m<sup>2</sup>.

The first two 160MW power generators were up and running in 1959 and 1960, followed by numbers 3 and 4 (larger, each producing 280MW) coming on stream and added to the grid in 1966 and 1969. At peak levels there were over three hundred employees.

### Production

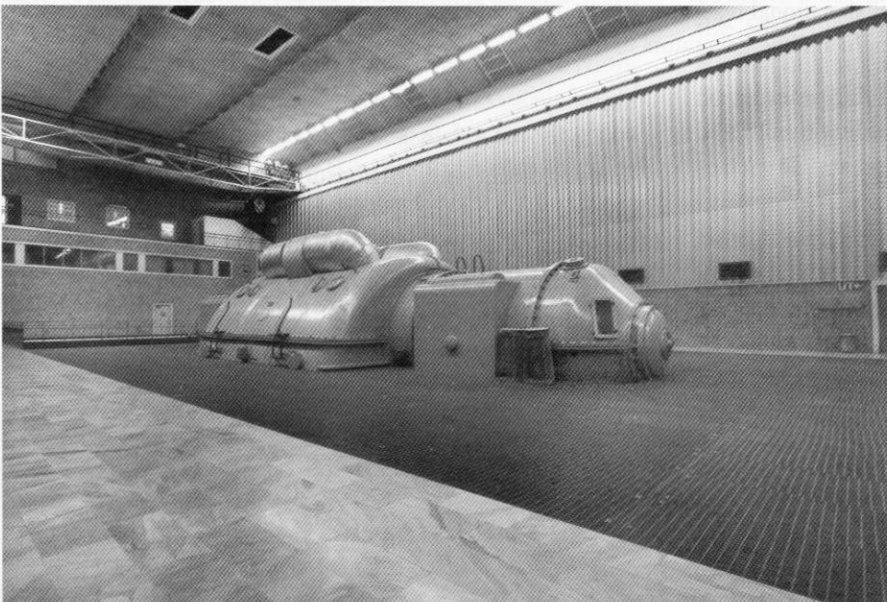
Stenungsund was run at full capacity during just a few years in the early and middle part of the 1970s. After that, production dropped rapidly and the site was more and more turned into a reserve power plant that only was started when there was a shortage of energy.

At its peak, the site produced almost five percent of the total need in Sweden but as soon as the first nuclear power plants started producing in the late 1970s, the importance of Stenungsund declined. With the first nuclear reactors up and running, they produced 20 TWh already in 1974 and by 1985 up to 60 TWh, a level that has been maintained up to present day.

It took 24 hours for energy production company Vattenfall to get the plant up and running. Vattenfall is still maintaining the plant, but with the minimum number of staff, to be able to produce power with generators 3 and 4 as and when needed.



The newer control room for generators 3 & 4



Generator in hall 1

### Modernisation

During the late 1980s a decision was taken to modernize the Stenungsund plant and make it more environmentally friendly and efficient. Between 1992 and 1996 all four generators were converted to run on lighter oil or even ordinary diesel.

In 1998 the next major decision was made when all the generators were conserved (mothballed). That meant that they could not be started at short notice but that they would last longer into the future.

In 2002 generators 3 and 4 were taken out of conservation and since 2003 both have been on standby to supply the Swedish National Grid when there is exceptional energy demand.

This first occurred during the cold winter of 2009–10 when generator 4 was used, and then again during December 2010. After the order from the National Grid

Today the main income for Vattenfall in Stenungsund is the supply of raw water to other industries in Stenungsund, as well as fresh water to the village. They also produce what is called “100 distillery”, a 99.9% desalinated water supply to the refinery close by. The company also runs the harbour with over four hundred ship movements annually.

### Visiting the site

To walk around the huge Stenungsund site deep underground is sheer pleasure. I've been there for two half-days and there are new things to see every time. Around twenty elevators and numerous stairways take you around and

without the guide you would soon be totally lost.

As mentioned before, the plant is made up of four generator halls in a row inside the mountain. There are two main entrances, both big enough for lorries. Nothing much is seen on the outside, just a few houses and infrastructure towards the sea. On top of the mountain are the four huge chimneys, which together with the big sub-station on the other side of the mountain are the most striking visible parts.

A total of seven kms of roads and pathways are divided into seven main tunnels. On many parts of the site there are eight floors that are connected with elevators and staircases.

The entrances have external gates for protection from break-in and for visual inspections. Further down the tunnels, around 150 metres, are the blast doors that can secure the complete site.



One of the two newer generator halls (3 or 4). They have been converted to run on light diesel fuel and are still in the Swedish national reserve to start up in cold climate. Burner and boiler to the right and the generators to the left

The spine levels out after another 150–200 metres on the lower level. Under this level is the cooling tunnel and the oil storage tanks. The oil is at its lowest at – 30 metres (under sea level).

The four generator halls are on this lower level with a height of approx. 40 metres. Each generator sits in a huge hall where most of the space is divided into two levels. From a view point high up under the roof there is an access to the telfer and the view from up there is amazing.

Around each generator there is room for manoeuvre, air intakes with giant fans, water cooling and the mid voltage transformers. Just the machinery to feed the engines with diesel is impressive – eighteen litres has to be pumped into each engine per second. That is equal to the usage for an average house during a whole year in less than three minutes! Per generator! As this was the first and only site built like this, there are numerous inventive solutions. Each generator is totally separated from the next with fire-protective doors. This in combination with the blast protection produces complexity when it comes to the air intakes when dealing with these huge amounts of air. Just to run a site like this at peak demand can cause problems. When all generators are down you need power to be able to produce power! When no power is accessible from the outside, there is a gas turbine just outside the mountain that can produce enough power to start one generator. When that is up and running, it can internally feed power to start the others.

### If the chimneys fell down . . .

The four chimneys also came under scrutiny when it was realized that they would draw attention to the site and could be a bomb target. If hit, they would probably collapse, in which case there would be a severe risk that they could block the exhausts from exiting the mountain, causing a production stop to the fully functioning plant below.

The chimneys start around thirty metres below the surface of the top of the mountain. They stand inside the mountain with a gap on all sides, starting at the level where the exhausts go from pipes into the chimneys. At this level there is a large space blasted out of the rock around each chimney with enough room to store a completely felled chimney. The plan was for the

chimneys to fall into these “bomb pockets” and still leave space for the exhausts to vent out of the site.

These rooms and infrastructure were first shown to outsiders when the Swedish version of SubBrit visited the plant with me as coordinator; the second time was when SubBrit visited in January 2011.

All photos Nick Catford



The bottom end of the huge exhaust pipes. Daylight can be seen far up. These four exhaust pipes are the only part of the power station that are above ground.



## The Bourne Park Tunnel, the Elham Valley Railway and HMG *Boche-Buster*

Nick Catford

### Early schemes

In 1832 the Kentish Railway Company proposed a railway line from Canterbury to Folkestone as part of their 1824 scheme to build a line from London to Dover via Canterbury from where lines would diverge to serve a number of large towns. The company was unable to generate much enthusiasm from potential local backers and the project was quickly dropped. Although this scheme failed, it wasn't long before a line was built between London and Dover. On 21 June 1836, Parliament passed an Act incorporating the South Eastern and Dover Railway, which shortly afterwards became the South Eastern Railway. The new company was formed to construct a route from London to Dover.

The chosen route, which passed over the lines of three other companies, would start at London Bridge from where it would use London & Greenwich metals as far as Southwark and then turn south towards Croydon. From a junction with the London and Croydon at Norwood the Dover line would then share the London and Brighton main line to Redhill where it would turn east towards Tonbridge, Ashford and Folkestone. Construction began in 1838 and reached Dover in 1844.

The 11-mile direct route from Folkestone to Canterbury follows two valleys with the Nailbourne stream running north from Lyminge and the Seabrook running south. Collectively they are known as the Elham Valley. In 1776 there was a weekly stagecoach service through the valley. The road however was in a very poor state of repair and there was clearly a demand, particularly from the poor tenant farmers in the valley, for a reliable means of getting their produce to market and for bringing goods in, especially coal.

The SER's domination of East Kent was soon to be challenged when the promoters of a new line from Canterbury to Chatham offered to lease it to the SER once completed. The SER turned down the offer as they were confident they would be able to buy it cheaply after construction.

Having obtained their Act in 1853, the Mid-Kent (later East Kent) Railway was soon in financial difficulty but they managed to secure sufficient finance to continue construction towards Canterbury. The line was again offered to the SER who again turned it down. This was soon to prove a bad decision as in 1855 the East Kent received parliamentary approval to extend their line south to Dover. Three years later they obtained running powers across the Medway into London. In 1859 what had started as a purely local venture became the London Chatham & Dover Railway (LCDR) which would soon become a major competitor to the SER.

This rivalry was soon to be used to the advantage of a number of influential landowners in Lyminge who had

previously been unsuccessful in persuading the SER to build a line through the sparsely populated Elham valley. In an attempt to get a line built, the first Elham Valley Railway prospectus was published in 1865. A Bill was put before Parliament in the winter of 1866 and although it was opposed by both the Lcdr and the SER it was sanctioned by Parliament. The company was unable to raise sufficient capital however, and the line was never built.

Relations between the SER and Lcdr had always been strained and became even more so after the Lcdr were awarded a lucrative cross-Channel mail contract after the SER had turned it down. In 1879 both companies submitted new proposals for a line through the Elham Valley. The Lcdr submitted their scheme first and so as not to lose out to its rival this was closely followed by the SER. The nominally independent Elham Valley Railway Company was established but the three principal directors had strong links with the SER. On January 1880 a Bill was presented to Parliament for a single-track light railway but was withdrawn before the first reading after objections were received including one from Matthew Bell, the owner of Bourne Park estate. A modified Bill was presented to Parliament the following year with guaranteed finance from the SER.

The Bill had a shaky passage with continued opposition from landowners in the valley and from the Lcdr but it was eventually passed on 28 July 1881. Having received authority the SER were, however, in no hurry to actually build the line. The Lcdr were still determined to reach Folkestone and quickly revived an earlier proposal to build a double-track line along the Alkham Valley from Keraney on its Canterbury to Dover line to a new terminus at Folkestone. A Bill was prepared to put before Parliament in 1884.

In an attempt to block this new financially damaging route, the SER revived the Elham Valley line with new enthusiasm. Although the Elham Valley line had already



The south portal of Etchinghill Tunnel in March 2012.  
Photo Nick Catford

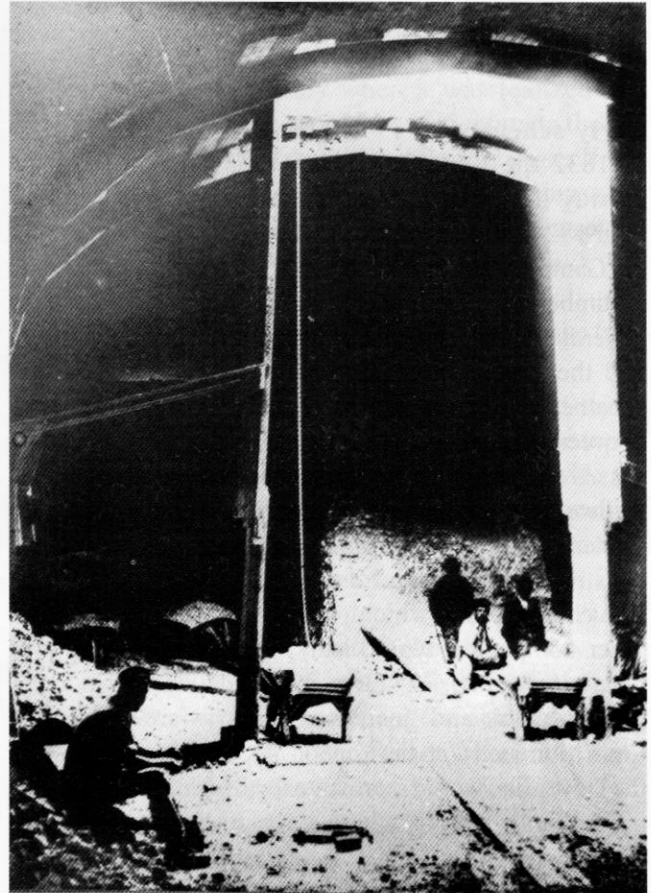
been sanctioned by Parliament it was only to be a light railway and as such could not be fully integrated into the SER network. The Elham Valley board agreed to upgrade the line to the same standard of the rest of the rail network and this was authorised in 1884. The LCDR eventually withdrew its Alkham Valley Bill leaving the way clear for the South Eastern to start construction of the Elham Valley, a line it had never really wanted but had been forced to build as the only way of stopping the LCDR

### Construction begins

The South Eastern's chief engineer Francis Brady was appointed to draw up plans for the 16-mile line which was to be built in two stages with the section from Folkestone to Barham being built and opened first. The contract for the first section was awarded to Thomas Walker who immediately started work driving the Etchinghill tunnel. The summit level at Etchinghill was the main engineering obstacle on the southern section of the line. Although originally planned to be 600 yards in length the tunnel was shortened to 97 yards by excavating an 80ft deep cutting at either end.

Construction was slow with many landowners reluctant to sell land for the railway. The strongest opposition came from Matthew Bell who owned Bourne Park House on the northern section of the line. Bourne Park is an attractive three-storey red-brick Queen Anne mansion overlooking water meadows. It is set in scenic grounds with a large ornamental lake and a long avenue of elm trees at the rear.

The preferred route through the estate was just 200 yards to the rear of the house where the line would run in a shallow cutting involving the removal of part of the avenue of elm trees and which would leave it in full view



Removing the chalk core from the centre of the Bourne Park tunnel in 1888. The chains hoisted up the full barrow loads which were then deposited on the top of the brick arching.

Photo from Brian Hart collection

of the house. Matthew Bell refused all offers of compensation. The case eventually went to arbitration in August 1887 and was finally resolved when Bell agreed to a shallow 300-yard cut-and-cover tunnel through the

estate approached by a deep cutting at either end. Bell was still not satisfied, however, and was ready to scupper the deal until the SER agreed to move the tunnel a short distance to the south to ensure the line was never visible from Bell's bedroom window.

The majority of the earthworks for the southern section were completed by April 1886 and just short of three years after construction started the track had reached Barham station and the southern section of the line was opened to all traffic on 4 July 1887.



Looking north from the roof of the cut-and-cover tunnel at Bourne Park during construction in 1888. Photo from Brian Hart collection

Despite poor relations with SER chairman Sir Edward Watkin during the construction of the first section, Thomas Walker was retained as contractor for the extension and immediately started work on the Bourne Park estate. This isn't the first time that a covered way has been provided to appease a landowner and the work is described in Matthew Bell's *Chronicles of Bourne*: "An open cutting was made as deep as the level of the arch springing and then a trench was dug on either side on which the walls of the tunnel were built. The arch was then turned, but with apertures left in it at regular intervals. Lastly the core of chalk left in the middle of the tunnel was removed by being hauled up in wheelbarrows on chain bridles, through the apertures, drawn by horses. The core was then deposited on the top of the tunnel until the cutting was filled to the original level." The bricks forming the roof of the tunnel were laid in early September 1888 and the tunnel was completed in February 1889. The northern section of the line opened on 1 July 1889 with six daily trains in each direction between Shornecliffe (now Folkestone West) and Canterbury West. Construction of the Elham Valley Railway had taken almost five years, averaging little more than three miles a year. Once completed, the line was 50 percent over budget and had the local company not been financed by the SER they would clearly have gone bankrupt at an early stage. The Elham Valley Light Railway Company was officially absorbed by the SER on 25 June 1891. Although built as a main line, the Elham Valley was in reality only an agricultural line serving no large towns and little industry other than agriculture. Test borings for coal were made in 1897 but nothing was found and the only industry ever served by the line was the Elham brick company which closed in 1905 when the clay was exhausted. During 1896 the Elham Valley Railway played its part in the East Kent military manoeuvres designed to evaluate local defences including the use of the railway for deploying big guns.

### World War I

While initial expectations for the line were encouraging, by the turn of the century passenger returns had peaked and began to decline. With the outbreak of war in 1914 the line came under government control. There was minor disruption to services to accommodate troop trains and the Elham Valley was considered a useful secondary or diversionary route. The line was used as such in 1915 when a landslip at Folkestone Warren closed the main line and the Elham Valley was used as a long diversionary route between Folkestone and Dover via Minster and Canterbury.

Although normal services were resumed at the end of hostilities, passenger numbers continued to decline with the first bus service running through the Elham Valley in May 1919. In 1923 the line came under the control of the Southern Railway and in an attempt to save money, they announced a singling of the line. This took a number of

years to implement but in 1931 the line was singled between Canterbury and Lyminge. Through the 1930s what was one of the most scenic lines in Southeast England settled down to a quiet existence with valley residents and passengers unaware of the upheaval that was to follow at the end of the decade.

### Military control in WWII

The outbreak of war in 1939 initially brought few changes, but by 1940 a German invasion was expected and on 25 October the passenger service between Lyminge and Canterbury was suspended and the military authorities took control of the line for the duration of the war. Passenger trains continued to run between Lyminge and Folkestone. The loops at Canterbury South, Barham and Elham were relaid and extra sidings were provided north of Lyminge and at Bourne Park where the former 'up' line was relaid as a loop through the tunnel. Two 12" railway guns were brought to the sidings at Lyminge but following an air raid they were moved to the cover of Bourne Park tunnel.



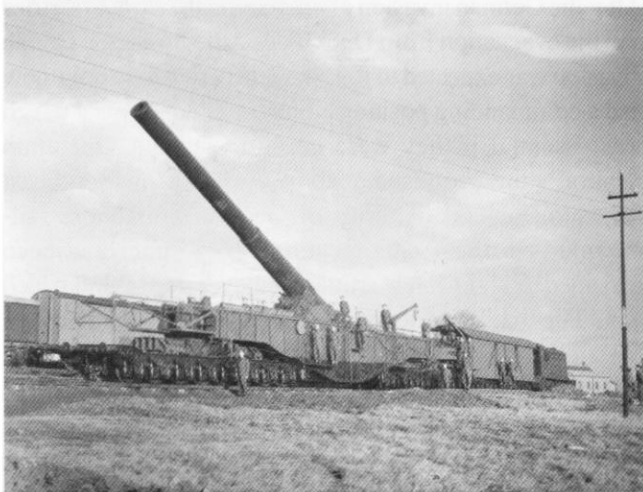
Looking north out of Bourne Park tunnel in March 2012.

Photo Nick Catford

After the German invasion of France and the Low Countries and the evacuation from Dunkirk of Allied forces, a British invasion was expected to follow. German artillery units now had a commanding position along the channel coast which was essential if they were going to launch 'Operation Sealion', the proposed seaborne assault on Southeast England. Several batteries of German guns were rail-mounted. In the 1930s the English Channel had been defended by short-range artillery left over from WWI which would be totally inadequate during the expected invasion. One of Winston Churchill's first tasks as Prime Minister was to search for extra firepower with three categories of defence required to defend the straits of Dover. Firstly there were long-range guns that could bombard targets in France, secondly there was need for intermediate-range guns capable of hitting enemy shipping in the Channel and lastly there was a requirement for mobile super-heavy rail-mounted guns that could be used against shipping and artillery targets and, if need be, withdrawn to pound the invasion beaches.

The idea of railway guns appears to have been first suggested in the 1860s by a Mr Anderson, who published a pamphlet in the UK titled *National Defence* in which he proposed the use of ironclad railway carriages. A Russian, Lebedew, claimed to have first invented the idea in 1860 when he is reported to have mounted a mortar on a railway car. Railway-mounted guns played an important role during WWI and Major Montague Cleeve was the commanding officer in charge of one railway gun, HMG *Boche-Buster*. The gun was originally a 14" designed for use on the Chilean battleship *Amiral Cochrane* which was under construction in Newcastle before the war. At 243 tons, it was the largest gun to be manned by the Royal Artillery in the field. (After the war the *Amiral Cochrane* was purchased from Chile and converted into an aircraft carrier, becoming HMS *Eagle*.) *Boche-Buster* was made famous when Major Cleeve fired 'the King's shot' near Arras in the Pas-de-Calais on 8 August 1918 during an inspection by King George V.

Two 18" howitzer barrels were also made for *Boche-Buster* and its sister *Scene-Shifter* in case the 14" ones were inadequate. They were designed to be fully interchangeable in the mounting. The design was completed in 1918 and two barrels were made but they were not ready until after the war when they were mounted and proved in turn, after which they were put into storage. After returning from France, *Boche-Buster* was also put into storage. In 1926 the 14" gun was declared obsolete but the mounting was retained and one of the 18" barrels was mounted on it. The gun was taken to Salisbury Plain and fired twice during the interwar years. On his return from the Far East in November 1939, Major Cleeve was given the task of tracing the WWI rail mountings and he also set up the School of Super Heavy Artillery at Catterick.



HMG Boche-Buster at Catterick in December 1940.

Photo from Wikipedia

New weapons were in short supply. Churchill had hoped to persuade the armaments industry to produce an entirely new railway gun against an almost impossible time-scale but he had to settle for second best by reactivating some

of the existing WWI artillery. Cleeve found *Boche-Buster* in a transport shed at Ruddington covered in cobwebs and was present when the doors were opened for the first time since the 1920s. During 1940 the carriage was taken to the railway workshops at Darlington (near Catterick) and after being mated with the 18-inch barrel from the Royal Arsenal it became the largest of the British WWII heavies.

*Boche-Buster* was manned by fifty men and several specialist gunnery officers from the 2nd Regiment Royal Artillery (RA); the complete battery of 80 men was known as the 11th Super Heavy Battery. The Elham Valley Railway was quickly made ready for the arrival of HMG *Boche-Buster*. Four brick magazines were built in the cutting north of Bourne Park tunnel and steps were cut into the banks either side of the southern portal of the tunnel where the gun would be housed. The military, it could be said, owed quite a debt to the stubborn Matthew Bell and his insistence that an unnecessary tunnel should be built so as not to spoil the view from his bedroom window.

Huge timber baulks were installed beneath bridges to support the girders as the 250-ton gun far exceeded the weight limit of the line. The Elham Valley branch was ideally suited to the needs of the War Department and to the big gun which could only fire parallel with the track. The meandering line allowed it to sweep virtually the complete southeastern corner of Kent, thus effectively enabling it to bombard any invasion force. A 200-yard camouflaged firing spur was installed into a new cutting in the fields west of the line at Kingston on the Charlton Park Estate where, by reversing, the gun could be aimed at Pegwell Bay near Ramsgate. Calibration shots were fired locally from there between February and April 1941. Capable of hurling a 6 ft shell weighing 1¼ tons some 12½ miles, it would have been sufficient to blast the coastline had the need arisen.

#### **HMG *Boche-Buster* arrives at Bourne Park tunnel**

After initial training at Catterick Camp, the battery moved south arriving at Bourne Park tunnel, its new home in February 1941, after a 43-hour journey from Catterick disguised as a string of banana wagons(!). On the bright spring morning of 13 February 1941, the gun was pushed out of the tunnel by a WD diesel locomotive, through Bishopsbourne station to the Kingston spur, where it was fired for the first time sending several rounds into the English Channel.

Although the villagers had been warned to open all their windows, considerable damage was caused in Kingston and Barham by the shock waves which brought down a number of ceilings. As a result, only two other test firings were made. It was on one of these trips that an officer in charge, on cautioning his men to be mindful of the low bridges, was promptly knocked unconscious himself as the gun passed underneath South Barham bridge! Apart from the blast damage the track had to be strengthened every time it was fired.



HMG Boche-Buster outside the south portal of Bourne Park Tunnel in 1941.

Mrs Roosevelt, the wife of the American president, visited Barham Women's Institute in an impressive double-headed train of seven LMS coaches.

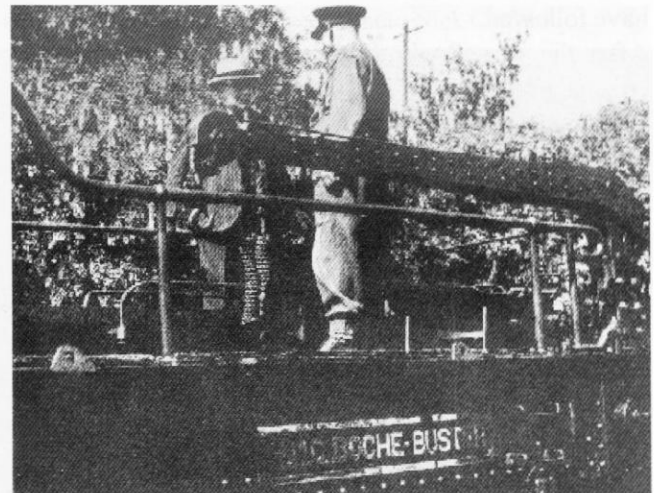
*Boche-Buster* was not the only rail gun to use the Elham Valley Railway. On 26 March 1943 the 13th Super Heavy Battery used the railway spur at Lyminge to test fire two 12-inch guns, No 1 gun to the west and No 2 gun to the east. On 1 January 1940 two 9.2" guns of 'Y' Battery of the Canadian Royal Artillery and 7th Battery 2nd Super Heavy Regiment were sited at Elham.

At the beginning of May 1943 the Southern Railway withdrew the passenger service between Lyminge and Shorncliffe and from then onwards the military were the sole users of the entire branch. In 1943 *Boche-Buster* found its way back to Salisbury Plain to fire trials of a new anti-concrete shell. By the end of 1943 all the other railway guns had been withdrawn from the Elham Valley and the units were disbanded. Although the anti-invasion guns were to spend long months waiting on the sidelines, if the Germans had crossed the Channel

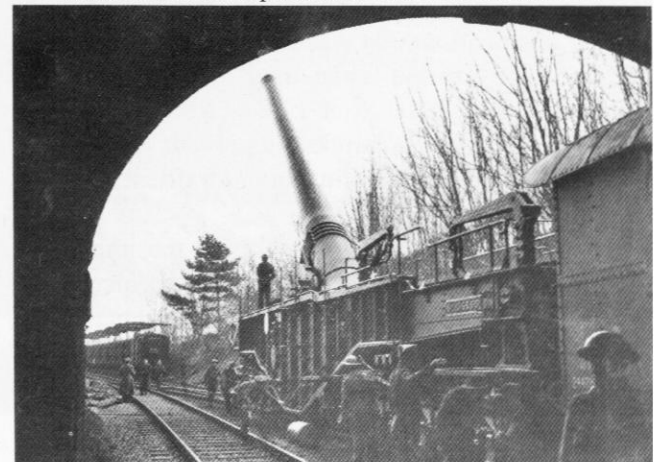


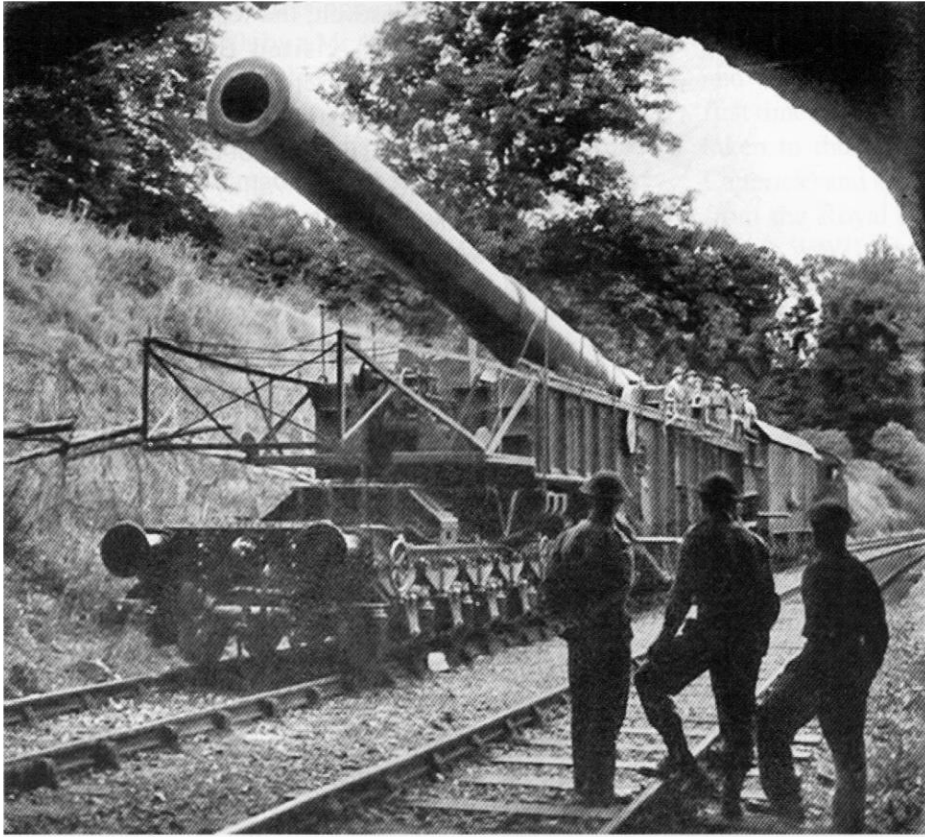
The south portal of Bourne Park tunnel in 1982.  
Taken from the same view point as above.  
Photo by Nick Catford

Winston Churchill inspected the gun at Bishopbourne on 20 June 1942 and later that day toured the gun emplacements at Elham and Adisham. The battery had its headquarters at Charlton Park with offices at Bishopbourne station. Although it was never fired in anger, the gun was frequently photographed in aggressive poses and was billed as a 'fearsome cross-channel monster' but the truth of the matter was that being a howitzer it had barely enough range to command the Kent coast and had no hope of putting a shell even halfway across the Channel. On 30 October Mrs Churchill and



Winston Churchill inspects Boche-Buster on 20 June 1942





HMG Boche-Buster seen from inside the south portal of Bourne Park Tunnel.

during the winter of 1940-41, the guns' firepower would have been a most significant factor in the battle that would have followed.

After the war, *Boche-Buster* was taken to the Royal Arsenal and cut up in the early 1960s. No railway guns exist today although one of the 18" barrels is still kept at Shoeburyness.

#### After the war

The daily goods service was reinstated from 19 February 1945 but the Southern Railway were reluctant to restore the passenger service. However in the summer of 1946 they announced that the line would reopen to passengers but only between Lyminge and Folkestone. The restored service began on 7 October but was little used as former passengers had now got used to travelling by bus and saw little reason to go back to the less convenient and less frequent rail service.

It was clear from this half-hearted effort to restore the service that the Southern wanted to close the line; so it came as no surprise when they announced in the following spring that the line would close from 16 June 1947 unless passenger numbers improved. With only 12 passengers a day and very little goods traffic it was clear that the line had no future.

There were some local protests about the impending closure but they fell on deaf ears. With no increase in passenger receipts the line closed to passenger traffic on 14 June 1947 and by 1955 all the track had been lifted and the Elham Valley line returned to nature. Today much of the route has returned to agriculture but the two tunnels

remain in good condition. There is a small railway museum at Peene adjacent to the line; this contains many artefacts of railway history and a working model railway depicting the line in SER days. From Peene the route can be traced through the Etchinghill tunnel with the 80ft deep cutting at either end.

The Bourne Park tunnel can be visited with permission from the Bourne Park estate. The north portal is at the end of a long dry cutting which, in the winter, is fairly free of undergrowth. It is best approached along a footpath from Bridge. Some of the brickwork around the portal has suffered frost damage and has fallen away although there has been no further deterioration since my first visit in 1982. There is a palisade fence across the tunnel mouth with a locked gate. Inside the tunnel is dry with the ballast still in place. The



The north portal of Etchinghill Tunnel in March 2012

south portal is in better condition and is crossed by a farm road/public footpath. This portal is at the end of a short cutting and is easily accessed from the farm road which runs parallel with the line from Bishopscourt station. There is no evidence of the steps that were cut into the bank by the southern portal which also has palisade fencing with a locked gate across the tunnel mouth.

#### Sources

*The Elham Valley Line 1887- 1947* by Brian Hart – Wild Swan Publications 1984

*The Elham Valley Railway* by M J Forwood – Phillimore 1975

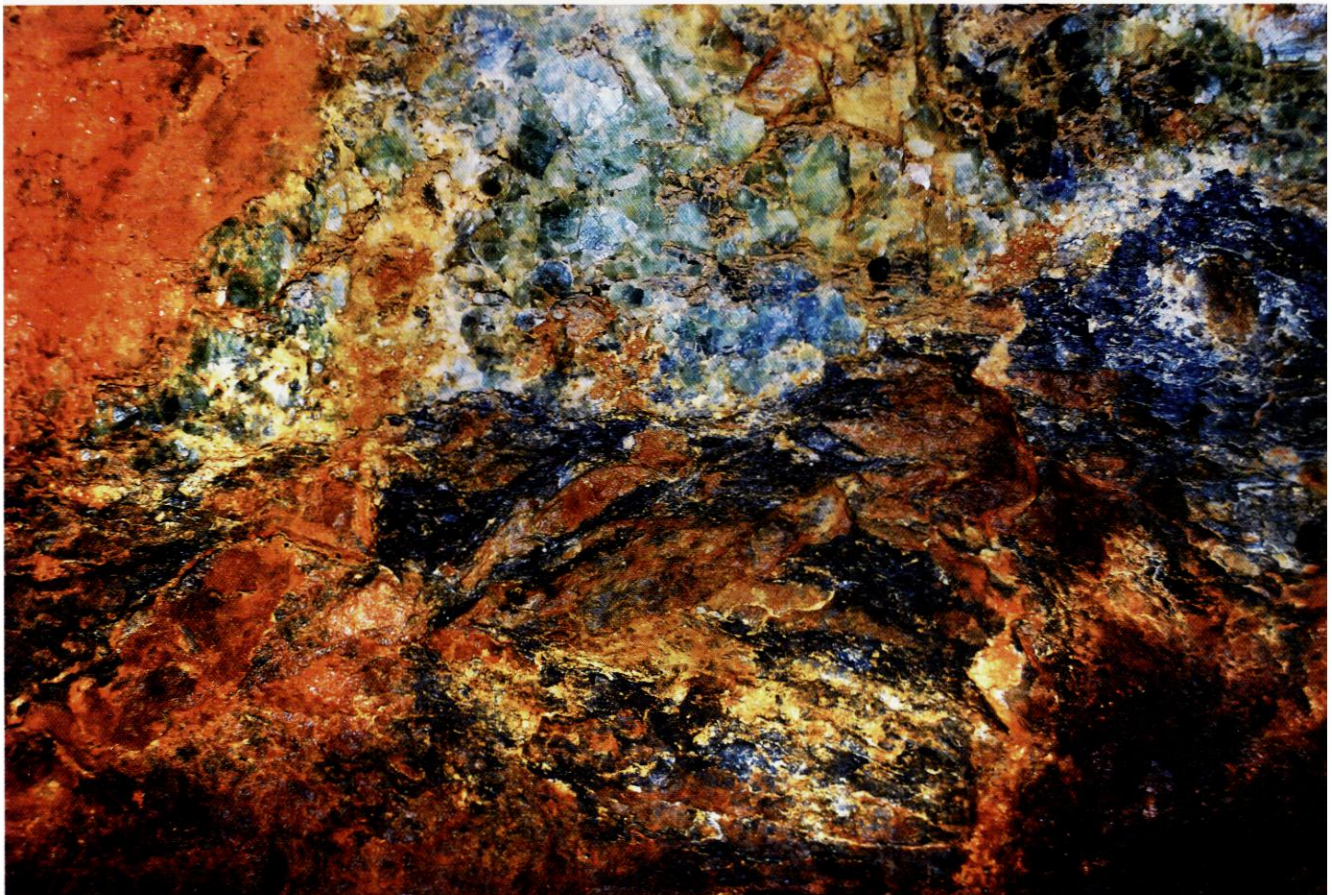
*Military Railways in Kent* by R M Lyme – North Kent Books 1983

*British & American Artillery of World War II* by Ian V Hogg – Greenhill Books 2002

*The Kentish Heavies* by John Reed – Article in *After the Battle* No 20  
Wikipedia - various pages



Bourne Park tunnel in 1998. The low profile of this cut-and-cover tunnel is clearly seen. Photo Nick Catford



Mineralised wall in the Glasebach Mine at Strassberg in the Harz Mountains in central Germany. Photo Ken Geddes



One of the passages in the recently re-discovered air-raid shelter in Carshalton Park, Carshalton, Surrey. Photo Nick Combes



Russian made air filters in the former Volksmarine command bunker at Tessin in Germany. Photo Nick Catford





Entering the flooded Rocket Silo Number 3 during a tour of a Titan 1 cold war ICBM site. The site is 568-C 'Royal City', originally one of three belonging to the USAF's 568th SMS sited around Larson AFB, Moses Lake, Washington. Photo Alex Gould



No 2 turbine hall at the Stenungsund power station in Sweden. One of the older 160MW generators is seen. Photo Lars Hansson



Inside the main chamber of the Arundel auxiliary unit's OB in Sussex. Photo Stewart Angell



Marsh, Son & Gibbs' last working crane in the Kingsdown Quarry in the Avon Valley in Wiltshire.  
The quarry is featured in Derek Hawkins' book reviewed on page 14. Photo Nick Catford

## Sussex WWII Auxiliary Units – Revisited

Stewart Angell

Stewart, a long-time member of Sub Brit, is author of *The Secret Sussex Resistance*, a founder member of the Sussex Military History Society (SMHS) and County Information Officer for Sussex within the national Coleshill Auxiliary Research Team (CART).

### Background

For those not familiar with the Auxiliary Units and their objectives during the Second World War, a brief background is required. The Auxiliary Units were, in effect, going to be the ‘British Resistance’ in the event of a German invasion of this country.



Colonel Gubbins

Colonel Colin Gubbins, based at Coleshill House on the Oxfordshire/Wiltshire border, was tasked with forming the resistance groups in May 1940, at a time when the threat of an invasion was very real. [See *Subterranea* 28 (December 2011) for details of the Coleshill Estate and its OB. *Ed.*] He gave them the deliberately nondescript title of ‘Auxiliary Units’, often

shortened further to Aux Units. No expense was spared ensuring the best weapons including plastic high explosives were available. These Aux Units were formed into small, localized patrols all around the country. Each county was allocated an Intelligence Officer, holding the rank of Captain, whose initial task was to create these patrols.

Although potential members of the Aux Units existed within the regular Home Guard, not all the men came from this background. It was considered essential that members had an intimate knowledge of their local area; consequently farmers, gamekeepers, market gardeners and people of similar professions joined their ranks, many being in reserved occupations. Everything about their existence was to be kept highly secret.

### Underground Hideouts

Each patrol required an underground hideout, known as an ‘Operational Base’ or OB. These were well hidden and purpose-built to house the patrol in the event of a German invasion. The OB also contained the necessary food, water, ammunition and explosives. To accompany the OB an underground lookout, known as an ‘Observation Post’ or OP, was also constructed. This would only have been big enough for one man and had a direct telephone link with the OB, allowing hostile troop movements in the area to be fed back to the rest of the patrol.

In the event of a German arrival, each patrol would secrete themselves inside their OB and let the invaders occupy their area, emerging only at night to perform acts of sabotage on German installations. Roads, bridges and railway lines were targeted for destruction and any German lines of communication or supply would be severed.

Geographically Sussex was in the front line of a German invasion and as such would have played a key role during the hours and days following the initial landings. The men who made up the Aux Unit patrols were all volunteers, highly trained and ready to ‘do their stuff unseen’ when darkness fell. Thankfully they were never needed as it was predicted that in the event of a campaign, patrols had a life expectancy of just two weeks.

Someone once said, “there are no secrets, just bad researchers”; in some respects this may be true but to anyone involved in research, whatever the subject matter, the last thing they would consider is being flawed by the very thing they aim to find ... information. There are a few times when I’ve fallen into this trap, thinking I am doing the right thing, followed the information given only to find I’d actually been sent in the wrong direction.

Having spent many hours in the field seeking out Auxiliary Unit bunkers, I know the thrill of finding the prize. However, I have also experienced the disappointment of finding absolutely nothing whatsoever!



Ashburnham OP entrance/exit tunnel with viewing point revealed beside tree roots

### Ashburnham – East Sussex

One such site was the Ashburnham Patrol Operational Base (OB) and Observation Post (OP). Information gained from a former patrol member gave me hope that their OB could still be in place, possibly the OP as well.



Looking towards the collapsed eastern end of Ashburnham OB

With map in hand and now an 'x' marking the spot, I had to wait a couple of days before getting a chance to look for the site. Despite a systematic search of an area that would have made an ideal location for the patrol's OB, nothing was located.

It wasn't until a few years later that I learnt the wood where I should have been looking was adjacent to the one containing that inaccurately positioned cross! The confusion came about from both these wooded areas having a similar shape, a mistake easily made by the former patrol member given the number of years since the site was operational.



Inside Ashburnham OP with emergency exit, viewing point and remaining section of corrugated-iron end wall

By transposing the cross into the other wood I now had the exact position for the patrol's OB, confirmed when I found the site on my return to the area.

Whilst there were parts of the construction that had collapsed, the main chamber and emergency exit tunnel were still in place. With an overall length of 26 feet, the design incorporated a corrugated-iron elephant shelter along with a combination of wood and flat corrugated-

iron sheets. Missing features were the low-aspect parallel brick walls used to support the curved elephant shelter. These walls were used for various reasons but don't appear to be obligatory, as other sites have shown. Their use did serve a purpose; the main ones being overall stability, gaining additional height within the OB and preventing the corrugated iron from sitting on a sodden base.

The entrance shaft was positioned at the western end of the OB with an additional section added onto the eastern end to accommodate a large-capacity water tank (200+ gallons) and an entrance into the two-foot-diameter concrete emergency exit



Ashburnham OB emergency exit tunnel with single course of brickwork still in place

tunnel running out in a northern direction for forty feet culminating in the bank of a small stream.

As is often the case, neither the entrance hatch nor the emergency exit covering has survived; however, a section of brickwork still in place at the end of the exit tunnel indicates the angle of its original wooden covering. A combination of pipe work indicates how ventilation was achieved; this was a mix of eight-inch-diameter thin metal



Ashburnham patrol's water storage tank with main chamber behind the photographer

tube, either side of the entrance shaft, and narrow 2<sup>3</sup>/<sub>4</sub> inch-diameter wrought-iron drainpipes positioned at the opposite end.

Continuing my search in a westerly direction I soon came across the patrol's OP, nearly 300 yards away from the OB. Effectively this was half an Anderson shelter making up the chamber and a six-foot-long, two-section concrete entrance/exit tunnel the same diameter as used in the patrol's OB. This was an unusual feature for such a small structure and breaks away from the standard roof-placed entrance hatch.

### **Crowhurst – East Sussex**

Another instance where it was suggested that the Crowhurst OB could be found turned out to be the correct location, in terms of the wooded area in question, but not so good with the accuracy. The other problem that soon became apparent during my investigation was the preponderance of shallow pits that looked just like collapsed underground structures.

This was a legacy of the area's iron-smelting days, long before operational bases were ever contemplated. With the absence of prepared timber, corrugated iron or brickwork to be seen anywhere in association with these depressions, the trail went cold. An accurate location came from an unlikely source...geocaching. Not that I have ever tried this treasure-hunting craze; it was a friend of mine who stumbled across what he thought to be the patrol's collapsed OB. On inspection it ticked all the boxes.

The overall size, shape and position certainly matched other sites in a similar condition, with evidence of a short exit tunnel, also collapsed, leading into the upper bank of a stream. This OB would have had a flat roof constructed out of wood and corrugated-iron sheeting. With only a few pieces of wood and scant remains of corrugated iron sticking out from the depression, these appeared to be the chosen materials for the overall construction, with nothing to suggest any brickwork was included. A search of the surrounding area failed to identify the location of the patrol's OP.



Crowhurst: distinct shaped depression highlighting position of collapsed OB

### **Arundel – West Sussex**

The Arundel Patrol's OB was believed to have been blown up after the war, a fate said to have befallen many an Aux Unit OB around the county. Former patrol leader Frank Penfold confirmed this fact to me back in the early 1990s.

Whilst the prospect of seeking out a demolished OB wasn't particularly inspiring, it would indicate the outcome of such a destructive act. A detailed search of the forest where the OB was sited revealed no evidence to support this fact. Ten years after my original search, information came through highlighting that a collapse had identified the OB to still be standing without any signs of an attempt to demolish it.

A visit to the site confirmed that the bulk of the OB was still in place and in relatively good condition. Constructed from the familiar corrugated-iron elephant shelter, supported on 15-inch-high brick walls along its whole length and with a solid concrete base, there are a few aspects that have not been used elsewhere in Sussex.

This OB contains two chambers which are divided by an internal corrugated-iron sheet partition wall that had a narrow two-foot-wide door. The main chamber is 17<sup>1</sup>/<sub>2</sub> feet long and contained the patrol's bunk beds along with some equipment. The other chamber is smaller, being 7 feet 8 inches long and would have contained the patrol's stores of plastic explosives, fuses, ammunition, food and water supplies. The overall height is 8 feet 2 inches throughout. There is little evidence of an entrance shaft; in fact it could be that this was the part intentionally destroyed after the war.



Arundel OB: the emergency exit, ventilation pipes and section of additional timber support frame

It appears that whoever constructed the structure did not trust the strength of the elephant shelter on its own as there are three timber frames used as additional supports which also brace themselves on top of the internal brick walls. This unusual approach has cleverly been integrated into the construction without taking up valuable internal space. A two-foot-diameter concrete emergency exit tunnel starts high up in the end wall of the OB running out for 50 feet into the side of a bank of soil.

Most of the corrugated-iron sheeting that made up this end wall has rusted away but in doing so has revealed the five-inch-diameter wrought-iron drainpipe used for the ventilation system still in situ. One of the bunk beds is still standing; made throughout from 4" x 2" timber, the bed frame measures 6 feet 4 inches long, 2 feet 2 inches wide and nearly 3 feet high. A formed wire mesh is stapled to this frame with wooden batons nailed over this stapled edge to give a neat finish. Having never found evidence of a mattress on any of the bunk beds encountered during my research, it may well be that simple blankets would have been used for this purpose. The patrol's OP is yet to be discovered.



Arundel OB: internal dividing wall with door frame still in place

### Hurstpierpoint – West Sussex

The Hurstpierpoint patrol's OB was known to have collapsed with only the corrugated-iron entrance shaft still visible. Knowing the accurate location for their OB made the chance of my locating their OP in the close surrounding area a distinct possibility. The slope and commanding view gained from a position above the OB would have been the obvious place to site the OP but a complete sweep of this area found nothing.

This was another site that would be highlighted years later by a friend showing me that the position was unexpectedly a far greater distance away than thought, twice as far in fact. The standard distance away from an OB would be around 300 yards. This accounts for the



Inside the now silted-up Hurstpierpoint OP

length of telephone cable issued to connect the telephones contained within the OP and OB. I was keen to see if there was any evidence of a cable to be found as the distance was greater than I had ever encountered elsewhere.

A site visit identified that the now heavily silted-up OP was constructed by burying a full-size Anderson shelter within a small wooded section of slope, giving an excellent view of the surrounding area. At the eastern end two sections of 4" x 2" timber uprights still support some of the flat corrugated-iron sheet that originally covered this end. On closer inspection, behind one of these wooden uprights was indeed a length of telephone cable exiting the structure and running up to the surface. Perhaps this greater distance away is not as uncommon as previously thought and may open up the opportunity of finding the position of other patrols' observation posts by applying this new approach.

### Wiston – West Sussex

One of the most frustrating and lengthy searches came about whilst looking for the OB of the Wiston Patrol. Convinced by others that the OB was located near to Chanctonbury Ring, I made repeated searches that revealed nothing substantial enough. Following a feature highlighting my book in the *Mid Sussex Times*, I received a phone call from Laurie Tooth, a former Royal Engineer who just happened to have helped build this elusive OB. Still living locally, Laurie agreed to take me to where the OB was sited but knew nothing of its condition.

The OB is positioned within a narrow wooded area that runs adjacent to a footpath regularly used by locals for walking their dogs. Unfortunately the structure has collapsed over the years but still contains some of the timber and corrugated-iron sheeting used in its construction.

Laurie explained how the site was made. Whilst some of the men dug the hole to accommodate the OB, others worked on a timber frame in the adjacent field. On completion the frame was then lowered into the hole and a roof containing an entrance shaft and hatch was added. The whole structure was then covered with soil and made to match in with the surrounding vegetation.

A good look around the site failed to establish if the OB had an emergency exit tunnel, an aspect that Laurie could not recall the site ever having. We did find a couple of the wrought-iron air vents still in situ coming to the surface in the ground close by. One of these still contained the telephone cable to connect with the patrol's OP. Unfortunately Laurie was not involved in the construction of this and its exact location is still to be determined.

### Conclusion

The Aux Units continue to be a fascinating subject, their past shrouded in secrecy, with little official documentary evidence available. There are still more patrol posts to be discovered all around the country. Any information



Wiston OB: former Royal Engineer, Laurie Tooth, inspecting the remains of his wartime construction

relating to the members of an Aux Unit patrol, the location of their OB/OP, equipment used or official documents would be much appreciated.

Stewart Angell

Unseen.sussex@gmail.co.uk 0771 4923925

All photos by Stewart Angell

#### References

- < *The Secret Sussex Resistance* by Stewart Angell, 1996 Middleton Press ISBN 9781 873793 82 4
- < Ashburnham Patrol OB – Mike Ridley
- < Arundel Patrol OB & Hurstpierpoint OP – Jim Whittington (SMHS)
- < Crowhurst Patrol OB – Nicholas Woollard (SMHS)
- < Wiston Patrol OB – Laurie Tooth (deceased)

#### Useful Websites

[www.ashburnham-past.co.uk](http://www.ashburnham-past.co.uk)

[www.auxunits.org.uk](http://www.auxunits.org.uk)

[www.coleshillhouse.com](http://www.coleshillhouse.com)

[www.parhamairfieldmuseum.co.uk](http://www.parhamairfieldmuseum.co.uk)

[www.subbrit.org.uk](http://www.subbrit.org.uk)

## Underground Disappointment at Hughenden Manor, Buckinghamshire

Stewart Wild

Hughenden Manor is a handsome brick-built house surrounded by woodland on the edge of the Chilterns just north of High Wycombe. Owned and managed since 1947 by the National Trust, it was the former home of colourful Victorian Prime Minister Benjamin Disraeli (1804–1881), and a stroll through its dozen or so well-furnished rooms provides a pleasant insight into a top politician's lifestyle in the Victorian period.

Equally if not more interesting is what went on here in secret during World War II. Codenamed 'Hillside', the house was requisitioned by the Air Ministry and became a secret base where maps were created from aerial photographs for bombing raids over enemy territory. In 2010 a new World War II display area was established in the basement, and since then other areas have been opened up to give visitors an idea of daily life in wartime secrecy seventy years ago.

Earlier this year I was attracted by a National Trust press release. "This year at Hughenden you can find out what it was like to spend time in a wartime air-raid shelter and also explore Disraeli's Ice House which was used as a photographic unit during the war," it said, quoting House Manager Nicholas Witherick. How could I resist?

The house is less than an hour from London. It doesn't take long to look round the rooms on the ground floor and first floor. Steep stairs down to the basement reveal fragments of the Tudor farmhouse that once stood on this site.

The basement display contains exhibits and a short film detailing the importance of aerial photography in World War II, how millions of negatives were taken by the RAF and processed in secret by RAF Medmenham (at Danesfield House, near Henley-on-Thames), and how stereoscopic images were used to create detailed but simplified maps that were delivered nightly to Bomber Command's navigators so they could pinpoint their targets. Maps created at Hillside were a crucial part of most major WWII flying operations including the famous Dambusters raid, the bombing of Peenemunde and air support on D-Day.

Also in the basement is a recreation of "Sergeant Hadfield's wartime living room" which I thought was reasonably authentic,

with a wide range of contemporary artefacts and sound effects. Away from the house, I couldn't wait to explore "Disraeli's Ice House", although this proved a disappointment. I entered – at ground level – through a shrouded doorway into a brick shed, one of three interconnecting structures with vaulted roofs that I later discovered were once storage outhouses giving access to a tunnel serving the alleged ice-house. But where was the tunnel? Two of the sheds have been fitted out with original and replica photographic equipment, including cameras and drawing boards, for this is where the precious German maps were copied and processed for reproduction by the several dozen staff in the main house. Personnel for Hillside were recruited from among artists and cartoonists in the same way that Bletchley Park recruited people who were good at languages and crosswords.

Having signed the Official Secrets Act, the team here, as at Bletchley Park, never spoke about their work, and it is only in recent years that the details of their brilliant clandestine activities have slowly surfaced.

It is on record that Hitler knew about Hillside, for it was at the top of a wish-list of priority targets found in a crashed German bomber, but the house and grounds fortunately came through the war unscathed, the only local damage being caused by a V1 in 1944 which blew out the west windows of the parish church a few hundred yards away.

Later I asked Nicholas Witherick about the location of the tunnel and the nature of the ice-house. "Well", he said, "we don't know exactly."

He explained: behind some shelving and cupboards in the first brick shed is the beginning of the tunnel. It was only discovered last year, and is blocked with rubble.

It is slowly being excavated by specialist staff including an archaeologist. They are sure it will give access eventually to the ice-house, which may also have been filled in. Until then, the only sign of Disraeli's summer ice supply is the tree-covered mound behind the brick sheds, but it's worth a visit anyway.

And what a moment that will be, when the ice-house is finally revealed. We'll keep members informed.

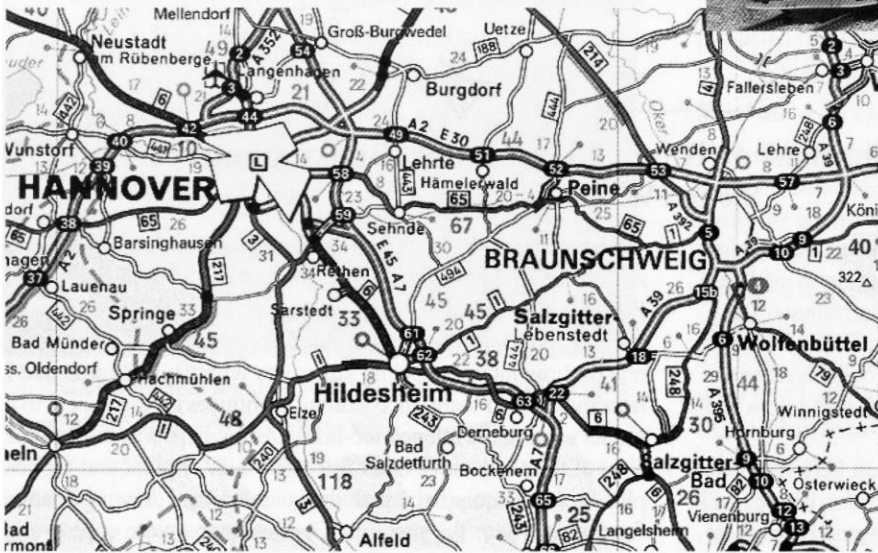


# Glückauf! : Harz Mining and Mining Museums, Germany

Ken Geddes

## 1. Introduction

The Harz Mountains are situated in central Germany where the states of Saxony, Saxony-Anhalt and Thuringia meet. They are close to Hanover in a southeasterly direction. The internal German frontier formerly passed through, with about a third of the region in the West and the remainder in the German Democratic Republic (GDR). The whole area is only around 68 miles from west to east and 22 miles from north to south. However, within this area there were at one time over one thousand working mines, dripstone caves (some partially mined) and surface stone quarries.



It is a very diverse area geologically with areas of shales, greywackes, granite, limestone and gabbros. The area is extensively faulted and folded. As a generalisation, silver and lead are found in the west, iron in the middle, copper in the east and coal around the fringes. The publication *Bergwerke & Höhlen im Harz* lists eighteen show mines, including three mined caves, but there are certainly several more – a few are closed or require prior arrangement to visit. In addition, there are accessible water supply and drainage tunnels, and part of the underground WWII Mittelbau-Dora forced labour factory at Nordhausen has been reopened.

The mountains rise dramatically on the west and north of the area from a flat plain. The highest is the Brocken at 1,141 metres, clearly visible from the train and road passing to the north. There are two nearby peaks above 1,000 metres. The area is heavily wooded with twisting and hilly mountain roads to make driving interesting.

However, there is the alternative of a large network of steam metre-gauge railways and a few remnants of standard-gauge branch lines. Additionally, the preserved Mansfelder Bergwerksbahn is a spectacular narrow-gauge line which served over twenty copper mines when it was working commercially. It now operates an occasional passenger service.



Double departure

The Harz area includes five UNESCO World Heritage Sites, including the Rammelsberg silver-lead mine at Goslar and – only this year – the unique “Upper Harz Water Regale”, a mine water-management system.

Mining started about 3,000 years ago and gave great prosperity to the area. Goslar’s wealth derived from the Rammelsberg mine. Water collection and storage to power the machinery resulted in storage lakes and collection ditches, many of which are still in use. The mines themselves have gradually become exhausted or uneconomic.

Only the GDR policy of self-sufficiency kept the last copper mine in the Mansfeld area working until reunification in 1990.

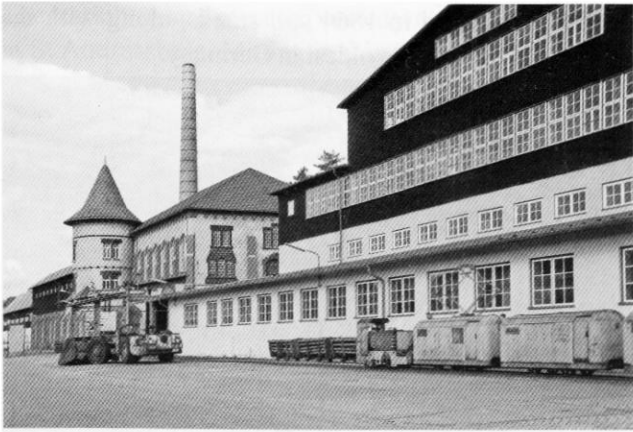
The last working mine was the Wolkenhugel Pit at Bad Lauterberg, mining barite. This used the most modern technology and struggled on until 2007, employing only fourteen workers, compared to the 1,000 it had once employed to mine silver, lead and zinc.

## 2. Silver-Lead Mining

The logical place to start is the 1992 World Heritage Site of Rammelsberg Mine, on the outskirts of Goslar. There were over 1,000 years of mining and refining here before closure in 1988. There is a choice of a mine-train trip or a walking tour.

The Roeder Gallery is reached first with three large water wheels, two in almost original condition, dating back over 200 years. A reconstructed double waterwheel is interesting as this was used for shaft haulage. As the buckets are set in the opposite directions, it reverses whenever the water supply is moved from one side to the other. Beyond this, the mine becomes twentieth-century with battery-driven locomotives and various wagons.





Rammelsberg mining museum. World Heritage Site

As an alternative to the train, it is possible to take the “walking trip”, entering by the original water tunnel from the reservoir or “Pond”. The tunnel has some nice copper and iron staining, as well as giving a different view to that from the train. I was the guide’s only customer and he spoke a mixture of German and English to me, usually in the same sentence!



Adit

The rest of the accessible site is devoted to a museum, much of the plant in situ. Ingeniously, doorways have been cut in the giant hoppers so they can be used as art and photographic galleries. Other areas are devoted to mine locomotives and stock and small artefacts and mineral specimens.

It would be difficult to leave without also looking at the bookshop – also trying the *Apfelstrudel* and excellent coffee. It is also worth walking up the footpath by the pond to the higher tips, past a shaft, with intriguing questions of where the spoil came from. There are good views of the site from here. Above the tips is a flat area which together with the tips is a nature reserve. In the woods above are many old shafts, now filled.

### Lautenthal silver-lead mine

Nearby Lautenthal was another big silver-lead production area. The mining museum is smaller, but well worth a visit. Again, a mine train accesses the underground, but there is also a demonstration flooded adit with a boat, reproducing the transport at lower levels of the mine. An interesting feature was a chapel where the miners held a service before work. The area was staunchly Lutheran until the plagues in the sixteenth century when Catholic miners from other parts of Germany were brought in. Unexpectedly, they all attended the services together. Unlike Rammelsberg, there are many adits and shafts around the town and major tips on the outskirts.



Demonstration of water haulage in lower levels.

The Adit is genuine

Following the Lautenthal Mines Trail, a flat area is reached, the site of the concentration plant for the ore. A steep upward track (an old incline?) leads to cross-paths following *graben* or water-collection ditches to a pit for a hydraulic engine, used for pumping. To the left from the incline is a waterwheel. Ahead from the waterwheel is another *graben* and an open tunnel beneath the tips. This is the water supply to the waterwheel and at this level a series of sluices control the flow of water to the wheel and also to an overflow.



Waterwheel driving *Fahrkunst* (man-engine)

Through the woods is a restaurant with some interesting old photographs on the wall – and good beer! There is a restored man-engine or *Fahrkunst* in the structure seen from below. Opposite is the gated entrance to a “coffin level” with the remains of a rusty door inside.



Very narrow adit entrance opposite top of flat rods.  
This may be a rebuilt entrance

### Other silver-lead mines

Clausthal-Zellerfeld was also a very important mining area and hosts the excellent Harz mining museum. Apart from many small items, the museum has constructed a demonstration mine, called "Princess Augusta Caroline", from pieces saved locally. It seems authentic and is a terrific demonstration piece. Behind the mine is a horse whim and flat rods; the building at the far end holds ore-crushing machinery.

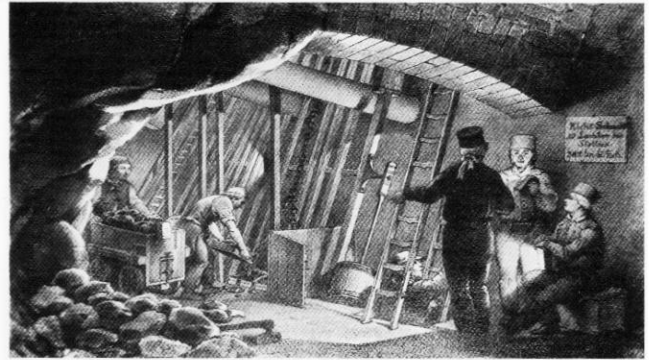


'Shaft' with ambulance tub

Nearby are the Kaiser Wilhelm II and Otiliae shafts and the *Radstube* (a shaft to the surface with a waterwheel for pumping). Water management was crucial to the success of the many mines and the first attempt to drain the Clausthal-Zellerfeld area was the Georg Stollen (238m/781ft deep) of 1799.

The Otiliae shaft was a haulage shaft for a number of independent mines down at this level. In 1864 this shaft was deepened to reach a new drainage adit, the Ernst August Stollen which was 26 miles long and at a depth of 380 metres/1,245 ft. The rebuilding closed the shaft for five years and a narrow-gauge railway was built from the Kaiser Wilhelm II shaft to bring the ore to the Otiliae shaft for working up. The underground ore boats were replaced by electric locomotives in 1900. The new

headgear installed in 1864 still stands, along with the winding gear, now the oldest in Germany.



This etching represents activity in the Richtschachter shaft, a part of the 'Good of Man' mine. The start date of this lead and silver mine is unknown but the Richtschachter was working in 1740 when dated silver coins were minted. There were two pairs of water collection ditches (Graben) below, leading to a concrete tank with a broken cast-iron pipe leading from it. This is associated with the pumping arrangements for the mine

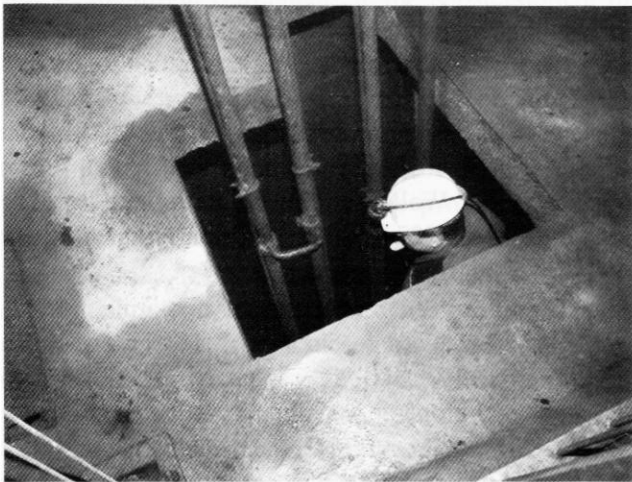


Headframe over Otiliae Shaft near Clausthal-Zellerfeld

The railway has been reinstated to bring visitors by genuine diesel-powered mine locomotives and man-riders from the bus station to the shaft. The nearby *Radstube* is a brick-lined shaft of impressive size. It is open to the public for a short time each day. The Kaiser Wilhelm II shaft at Clausthal has its original headgear. It is situated next to the School of Mines and has a small museum containing some interesting models and maps. It is administered by the Harz Water Authority, which is responsible for both the provision of domestic water and drainage, including the remnants of the mining water tunnels and ponds.

The last silver-lead museum visited was the Samson mine at St Andreasberg. Mining in this area probably started in the thirteenth century. Samson mine operated from 1521 to 1910 and was unique in having not only the usual galena, calcite, chalcopyrite, zinc blende and pyrites but also elemental arsenic and pure silver. Its second and more durable attraction is its *Fahrkunst* (“man-engine”), the only remaining working example in the world.

It was installed in 1837, only four years after the idea was invented by Master Miner Dorrel. The *Fahrkunst* is operated by a crank and rod system, 23 metres long. It operated down a shaft of 810 metres (2,654 ft). It reduced the time of exiting after a shift from two and a half hours to 45 minutes.



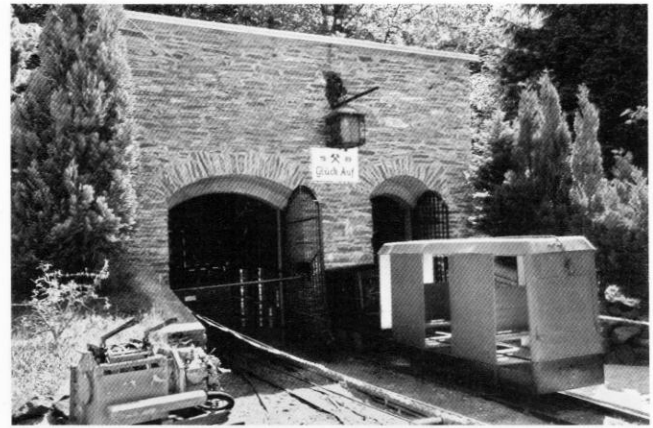
*Fahrkunst* (man-engine) at Samson. The last working original in the world

The *Kehrradstube* houses a reversible waterwheel of nine metres diameter. The show mine and museum are not big but interesting. Opposite the mine was another show mine, the Catharina Neufang, but that was closed due to lack of volunteer staff. There are other underground museums including show caves and other museums such as the Knesebeck Schacht mine museum at Bad Grund.

### 3. Iron Mining

There are at least three haematite or pyrites show mines in the Harz region: the Buchenberg mine at Eblingerode, the nearby Drei Kronen & Ehrt mine and the tiny Roter Bar mine at St Andreasberg, close to the Samson silver-lead mine. Only the Buchenberg mine museum was visited because the Kronen & Ehrt was temporarily closed due to a shortage of volunteer staff. The Roter Bar Pit, working from 1800 to about 1860, was revived from time to time and was taken over after final closure in 1950 by the mining college at St Andreasberg. From 1988 it has been maintained by the local Society for History and Archaeology, who arrange visits.

Buchenberg has extensive underground mining dating from the ninth century. However, only the top level is accessible due to flooding, after closure in 1970. Particularly interesting is the underground loading



Entrance to inclined haulage shaft at Buchenberg

equipment, especially the semi-automated feed of ore from hoppers into buckets on a cableway. This reaches the surface up an incline and the first tower is just outside the compact museum yard. The need for this rather exotic transport feature is because of the sharply sloping nature of the site and the heavy winter snows.

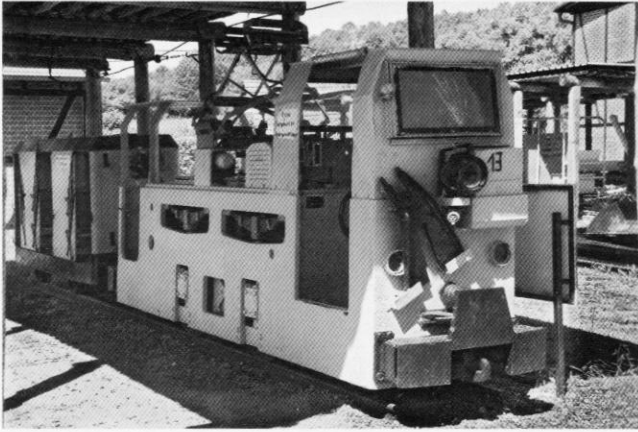
There are two other iron mines, both at Bad Grund, neither of which I visited. They mined limonite (ferric oxide-hydroxide), deposited in caves at the base of the Iberg limestone anomaly. The high carbon dioxide concentration is said to be from the reaction between siderite (ferrous carbonate) and oxygen-containing water to produce limonite and CO<sub>2</sub>.

The Eisensteinstollen, possibly the longest natural cave system in Germany, opened as a mine in the sixteenth century and has six kilometres of passages. It is connected with the Iberger Tropfsteinhöhle which was mined slightly later. The former mine has been used since 1889 for Speleotherapy, where people with respiratory illnesses spend hours underground. There is a door at the far end of the therapy area which leads to the cave/mine proper. The Iberger Tropfsteinhöhle (“stalactite cave”) became the Iberg Dripstone Show Cave in 1874, and was recently developed and renamed again HohlenErlebnisZentrum.

### 4. Copper

Silver was the initial attraction, although copper was also mined at Rammelsberg in medieval times. Later silver-lead and zinc were produced and copper forgotten. There are deposits of copper throughout the Harz, and in the period between 1199 and the closure of the last mine in 1990, there were about 270 copper mines around Sangerhausen, in the east of the Harz region.

The Rohrig Schacht at Wettelrode is a very special show mine. It mined the largest copper ore deposit in Europe. However it was “copper slate” with a copper content of only 1 – 3 percent and the vein was only 30 – 40cm thick. The surface exhibits of the museum are impressive, with neatly labelled machinery of all kinds, dating up to 1990. The shaft (280m/920ft) is still in excellent order and connects with a mine train, taking visitors 800m into the deposit. The winding house can be also be visited.



Rohrig Schaft surface display

Copper slate is a bituminous slate rather than schist, containing copper sulphide and some silver. The geological horizon is the Permian. The slate comes in a range of colours and is still used for floor tiles.

The major mining and production area for copper was centred between Klosters-Mansfeld and Hettstedt. This area is at the fringe of the mountains, in rolling countryside. Mining started in 1199 and around one thousand mines were sunk.



Mansfelder Bergwerksbahn branch to Brosowski Mine (1907-69) and turning triangle, Siersleben

Production was boosted in 1885 by the construction of the Mansfelder Bergwerksbahn, a 5.5 km narrow-gauge railway (750mm) initially connecting the Gluckhilm mine with the Kupferkammer smelter at Hettstedt. However, by 1930 it had extended to 95 km serving thirteen mines and two or three smelteries, including the Zirkel mine which had a depth of 800 metres.

The line also had two interchange stations with the standard gauge and extensive workshops. Its peak traffic occurred in 1955 after which it was a story of decay, with the last mines at Eisleben and Hettstedt closing in 1964 and 1969. The smeltery at Eisleben closed in 1972, while the smelteries at Helbra and the Hettstedt and the power station at Hettstedt all lasted until 1989; only a copper reclamation plant is now working. The railway was restored by volunteers and reopened in 1990 as a heritage railway.

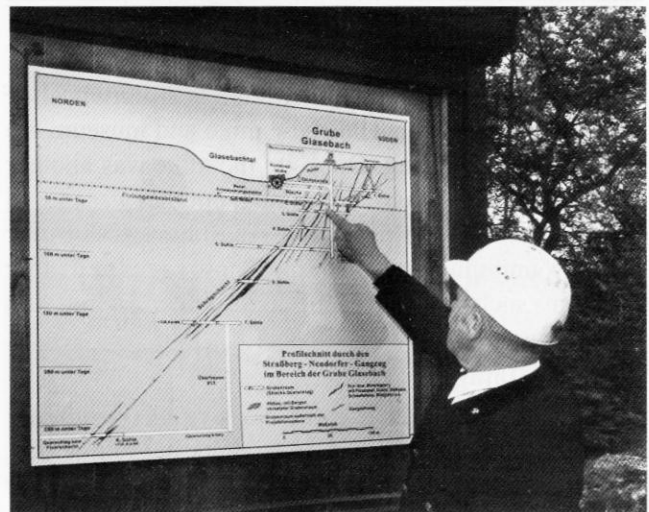


Copper mining

## 5. Other minerals

Zinc was a comparatively late interest; sulphidic zinc and lead ores were often found together. Only when galvanised iron became popular in the mid-1800s was a market found for the zinc. As previously noted, Barite mining at the Wolkenhugel Pit at Bad Lauterberg continued until 2007 by which time its 1,000 workforce had shrivelled to just fourteen.

There were fourteen granite quarries operating in 1951, but this had reduced to eight by 1958. There is also limestone in places, which was quarried. At least two large quarrying operations are currently active, one on the Iberg Mountain at Bad Grund.



Map at Glasebach Mine

The Glasebach mine at Strassberg produced silver-lead in the eighteenth century, copper in the nineteenth century and fluorspar from 1890 to 1990. It was notable because of the steeply dipping (50 degrees) mineral deposit and because it was the largest fluorspar deposit in Europe.

## Coal Mines

The large amount of timber required for props and for fuelling the smelters deforested the Harz region on at least two occasions and it is no coincidence that the peak of production occurred after the coming of the railways, which were essential for carrying the ore and refined

metal away for export from the area, and also to bring in coal from the Ruhr.

The only coal-mine museum in the Harz Mountains is the Bergwerke Rabensteiner Gallery (or Stollen), near Ilfeld, north of Nordhausen, and referred to as a “stone coal” mine, which is a mistranslation of the German *Steinkohle* – anthracite. It simply mined a hard coal which sold locally.

Just outside the Harz Mountains region, close to Hanover and in the Deister hills is the Feggendorfer Stolln mine, near to Lauenau. This was a small local mine, started in 1831, although three small shafts mined coal in 1738.

At the same time another mine was started on the other side of the hill at Barsinghausen, the Klosterstollen. In 1862 the two were connected, dramatically improving ventilation. The Feggendorfer Stolln reached the coal in 1840 after 995m. It quietly prospered, supplying fuel to the surrounding villages, its annual production rising from an initial 840 tonnes per annum to 1,600. However, after political changes, including state promotion of the Barsinghauser mine, Feggendorfer closed in 1879.

The import into the district of higher quality Westphalian coal by the railways and the Great Depression of 1873 – 1895 did not aid its cause. Fortunately, the adit was maintained as an access to the Hohenbosteler Stollen water supply for Barsinghausen. This allowed the mine to be reopened in 1917, via a further access tunnel, the New Feggendorfer Stolln. A rope-worked incline was built in 1921; production at this time was 80 – 90 tonnes per day with a workforce of 139.

Production eventually ceased due to narrow seams making production more expensive than the Westphalian coal brought by the railway, but revived in the desperate times of 1945–47 when there was extensive pillar robbing, with predictable consequences. In 1952 all the buildings were demolished.

The Klosterstollen mine closed in 1955 and suffered an internal collapse in 1974 which caused extensive flooding, forcing the construction of a drainage tunnel. This dewatered the mine and in 1986 a group started a show mine, opening in 1999, using a mine train to take visitors to the face.



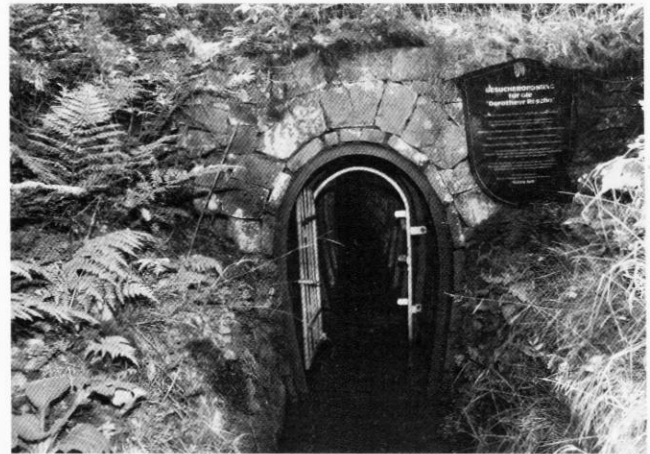
Feggendorfer Stollen coal mine: the way on!

Meanwhile, another local history group restored the Feggendorfer Stolln entrance over the period 1982 – 1990, but in 1998 a major collapse totally closed the adit. Five years later the current group started the mammoth task of restoring access with no funds and very few mechanical tools. Within a year they had removed 670 barrows of debris, secured the first 25m and drained the mine of a metre depth of standing water.

Soon they realised that they had reached a fault and needed to create a new deviation passage to reach the first target – a junction of passages. This was achieved by 2011. All tunnel supports are now fabricated from steel railway lines and this will avoid collapses of rotten wooden props.

#### **6. Services: Water supply and drainage, ventilation, electricity generation and railways**

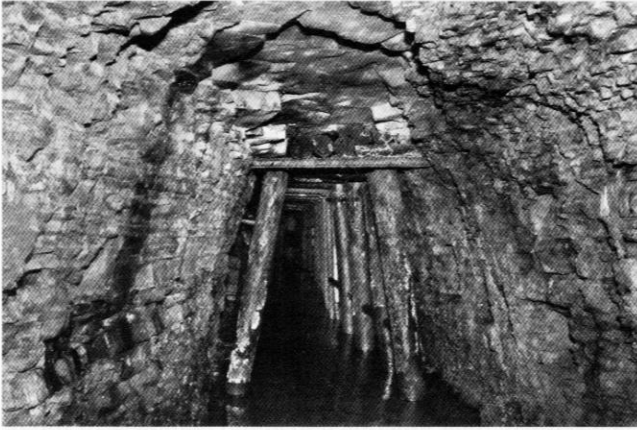
The system of water collection, storage, reuse and eventual drainage in the Harz is unique and has been justly awarded World Heritage Site status. It is extraordinary that the origin of the system of ditches, ponds and small streams goes largely unnoticed by the casual tourist in a landscape greatly admired for its beauty. However, the local water and drainage authority (Harzwasserwerke) is quietly carrying out a programme of drainage and removal of heavy metal-contaminated sediments from the most polluted ponds.



Dorotheer Roche entrance  
(drainage from underground waterwheel)

The Dorotheer Roche (water drainage system) can be visited by parties by prior arrangement. It is in reality the tail race of the Dorotheer Pit waterwheels. The water authority has a small museum at its Clausthal base next to the Clausthal University of Technology. Also on this site is the head frame of the 1,023m Kaiser Wilhelm II shaft, the second oldest head frame in Germany and the last pit to close in Clausthal (1930). There is also a *Fahrkunst* (man-engine) and a *Wassersaulenmaschine* (a water-operated pump).

Prior to the introduction of steam- and then electric-powered pumps and lifting equipment, the mines relied on water power through waterwheels. The system – the “Water Regal” – was built over the period of 1536 to



Inside the Dorotheer Roche water drainage system 1866 and eventually totalled more than 120 reservoirs (ponds), 500 km of ditches and 30 km of underground water tunnels. Even now, 65 ponds, 70 km of ditches and 20 km of tunnels are actively maintained.

As an example of the scale of this work, by 1567 the water requirements of the mines around Clausthal – Zellerfeld exceeded supply. A long ditch was created from the Bruchberg and Brocken mountain areas. The centrepiece of this construction was an aqueduct of 953 metres.

The early use of railed mining trucks in German mines was shown in the book by Agricola, published in 1550. This technology was brought to Britain by German miners. Wooden rails were used, iron rails superseding wood in a mine near Hanover in 1775. However, iron rails were already in use at Coalbrookdale by this time and were being exported to Europe by the end of the century. There is a good collection of old mining trucks of the English and German design at the Lautenthal museum.

### **Railways**

In Britain the early use of steam motive power by Trevithick was improved dramatically by Timothy Hackworth and George Stephenson. British manufacturers were well represented at the Leipzig Fair in the 1790s and the high-quality cottons and other goods made the local manufacturers realise that they must modernise. In particular they needed to establish efficient transport links.

Two German mining engineers visited Britain in 1826 and reported on thirty or forty wagonways, the steam-powered Stockton and Darlington line and the under-construction Liverpool and Manchester Railway. In May 1835 money was successfully raised to build a line between Leipzig and Dresden; a Scottish engineer, James Walker, was engaged to plan the route. The surveying was carried out by John Hawkshaw who had previously worked in copper mines in Venezuela and on the construction of Liverpool Docks.

After the success of this line, main-line standard-gauge railways were rapidly built, including lines to the north and south of the Harz Mountains.

Although high-quality coal was now more available via the railway, the Upper Harz mines were content to continue to use water power. However, in the flatter area to the east, water power for pumping was less effective and the first steam pumping engine of the James Watt design was erected in 1785 at the Koenig Friedrich mine near Hettstedt.

The first standard-gauge line to penetrate the mountains was the Innerste Valley Railway, built 1874–1914. It was finally closed in 1976, following the 1967 closure of the Clausthal–Zellerfeld and Lautenthal mines. The track remained until the railway’s centenary celebrations in 1977 but was lifted immediately afterwards. Many of the stations, embankments and bridges remain.

The 1886 Rubeland railway was another standard-gauge railway built largely for mineral traffic from the Rubeland, Kaltes Tal and Hornberg quarries and lime works. Although closed in 1963 and the track lifted, it was not abandoned, allowing the track to be relaid and electrified in 1977 and to be upgraded in 2007. In 2008, 1.7 million tonnes of lime and limestone were handled. The section between Blankenburg to Rubeland is the steepest adhesion-worked standard gauge line in the world.

### **Narrow-gauge Railways**

In 1886 a narrow-gauge line was built from Gernroder to Harzgerode. In 1896 the Nordhausen–Wernigerode followed, and a year later the Sudharz railway. These were all constructed to the 1,000 mm gauge and interconnected, with three interchange stations with the standard gauge. They were built to supply the mines and to take out mining products and timber. There was however a far-sighted eye on developing the tourist trade, especially with the building of the Brockenbahn in 1899.

After problems with the war and subsequent partition of Germany, the lines have been restored under common management, although there was opposition from the environmentalists to the rebuilding and reopening of the Brockenbahn in 1992. The total track length is 140km and the highest point is Brocken station at 1,125m.

The railway operates an all-year-round timetable with 25 steam engines, sixteen diesels and six railcars. It provides a spectacular journey to the summit of the Brocken in the snow. About a million passengers and 70,000 tonnes of gravel are carried each year.

A new development is the introduction of “Duo” tram/railcars, which leave the streets of Nordhausen and take to the railway tracks north to Ilfeld. Modern railcars serve other off-peak services.

### **Drainage adits and tunnels**

Deep drainage adits were tunnelled under several ore fields. The 19-Lachter Stollen at Wildemann was driven manually from 1551 to 1690 and is 8.8 km long. This tunnel also contains the “blind” pit Ernst-August Grube. A deeper drainage adit, the George Stollen was completed in 1799, but in 1851 an even deeper tunnel was started.

The work was completed in 1864 as the Ernst-August Stollen. It has a height of 2.5 m, width at midpoint of 1.7 m, a length of 26 km and an average gradient of 1:1.5. The outlet is at Gittelde.



Entrance to 19-Lachter Stollen

The adit collected water from the mines in Bockswiese-Hahnenklee, Lautenthal, Zellerfeld, Clausthal and Wildemann and was also used for boat transport of ore. The Otiliae shaft at Clausthal connected with it and was the central haulage shaft for the Rosenhofer and Berstatter ore deposits. The ores were taken to the Kaiser Wilhelm II mine for processing which was at the time the most advanced in Europe.



Passage in the 19-Lachter Stollen (1 Lachter = ~1.9 metres)

There was also an extensive drainage system in the Hettstedt area. The first drainage tunnel (the Ross Stollen) was dug in 1551 and by 1556 there were four such tunnels and one more at Sangerhausen. By 1571 these were serving 130 shafts employing 1,500 miners.

As the mines became deeper it was necessary to pump the water up to these water drains and, as noted earlier, the Watt steam pumping engine at the Koenig Friedrich mine at Hettstedt entered service in 1785. However a deep drainage tunnel of 31 km was still needed, built from 1809 to 1879, discharging even now 25 cubic metres a minute of saline water.

At least two of the disused mine shafts connected to drainage adits were subsequently used for the generation

of electricity. The Otiliae shaft was an example where turbines were placed in the drainage adit after the mines closed. It produced 10MW hours per year of electricity from 1930 until 1980 when the water licence expired. A similar operation in the Kaiser Wilhelm shaft produced four and a half MW hours per year. Water falls from the top of the shaft, through the turbine and exits along the drainage adit.

The longest water supply channel (*Kunstgraben*) is claimed by Silberhutte, an erstwhile ore processing area which included a small silver smelter whose annual output from four furnaces was 1.6 tonnes of silver and 870 tonnes of lead. The complex also manufactured sulphuric acid, gunpowder and later fireworks. The water channel was 25.5 km in length. Now Silberhutte is just a pleasant village.

### 7. Other mining remains

Waste tips abound throughout the region, especially around Lautenthal and Hettstedt. There are also substantial remains of buildings and head-shafts at Silbernaal 3 at Clausthal, and the Schmid shaft at Helbra.



Silbernaal-3 mine at Clausthal

On the opposite side of the road to the Schmid shaft is the superb Malakow tower (winding tower) and remains of standard-gauge tracks. There is a shaft and tips above the buildings at Rammelsberg. There are mine ponds everywhere and an outlet from an underground overflow (*Wasserlauf*) from the Kranicher Pond at Hahnenklee.

### 8. The future of mining in the area

There are no remaining working mines in the Oberharz region, but in February 2009 results of geophysical investigations by Harz Minerals GmbH were published, which showed previously unknown mineral deposits of similar size to Rammelsberg to be present just 2 km west of the Rammelsberg museum mine.

At the end of January 2010, the company announced that they would be drilling to 800m where they expected to find rich mineral deposits. During its lifetime, 30 million tonnes of ore were extracted from Rammelsberg.

All new pictures by Ken Geddes

## Remains of Manchester Picc-Vic tube system unearthed

A mysterious space recently found under Manchester's Arndale shopping centre has been identified as the initial stages of a long forgotten underground railway through the city centre.

The space which has been forgotten for decades and closed off to the public is under Topshop about 30 feet below the surface and was built as part of a subway linking Manchester Arndale to the new station.

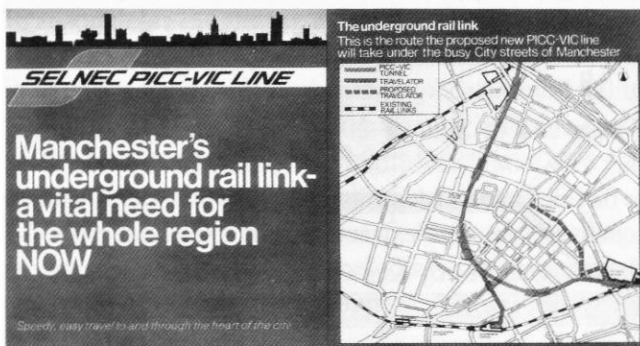


The void beneath Topshop in 2011.

Photo Charlotte Martin – Arndale PR manager

The South-East Lancashire and North-East Cheshire Public Transport Executive (SELNEC PTE), the local transport authority which became the Greater Manchester Passenger Transport Executive (GMPTE) in 1974, made a proposal in the early 1970s to connect the various railways running through Manchester city centre under the Picc-Vic scheme. The Picc-Vic proposal envisaged joining the two halves of the rail network by constructing new 18ft-diameter tunnels (costing £9,271,300 at January 1973 prices) under the city centre, connecting Manchester's two main railway stations, Piccadilly and Victoria. This new underground railway would be served by three new underground stations, joining together the regional, national and local rail networks with an underground rapid transit system for Manchester.

As well as linking the two mainline stations, Picc-Vic tunnel would improve the distribution arrangements from the existing railway stations which are on the periphery of the central core and improve passenger movement within the central area.



The proposed line formed part of a four-phase, long term strategy for GMPTE over 25 years, which included bus priority, an East-West railway network, as well as a light rapid transport system.

Parliamentary powers were obtained in 1972 and formal plans were made to start construction works in September 1973 with a target completion date of 1978.

An underground excavation and construction project required a large initial outlay of public funds, and when the Greater Manchester County Council took on the project, it was unable to secure the necessary funding from central government. The infrastructure grant application was turned down in August 1973 by John Peyton, Minister for Transport Industries. The minister cited announcements of £500 million reduction in public expenditure by Chancellor of the Exchequer Anthony Barber saying, "there is no room for a project as costly as Picc-Vic before 1975 at the earliest." The Picc-Vic scheme was abandoned in 1977.

The proposed new link would have been 2.75 miles long, and run from Ardwick Junction, a mile south of Piccadilly Station, to Queens Road Junction on the Bury line, about three-quarters of a mile north of Victoria. Just over 2 miles of the new line would have been in tunnel, most of which would be 60–70 feet beneath the centre of Manchester. The southern approach ramp would have been built on the surface and in a shallow tunnel.

There would be two separate tracks, each electrified on the 25kV AC system. In the deep tunnel section there would be separate bores for each track. The track would consist of continuous welded rails on concrete foundations known as 'slab track'. The tunnel would be controlled by BR's standard three-aspect colour light system together with their automatic warning system (AWS). This would permit train frequencies of 90 seconds, although initial proposals envisaged a 2.5 minute headway. Five new central area stations were planned on the Picc-Vic line, including two low-level platforms at Piccadilly and Victoria stations. Each would have been built on a straight section of track and would have taken trains of up to 8-cars. There would have been escalators to the surface level, and lifts for the disabled. CIS and PA systems would be installed, along with CCTV to make high staffing levels unnecessary.

Piccadilly Low Level would be a side-platform station, built in a 'cut-and-cover' section, with a mezzanine level concourse. Escalators would take passengers to both the Picc-Vic and East-West platforms, along with a subway-escalator link to the mainline station concourse, and a direct link to a new 12-stand bus station, next to the new station. Victory House, a planned development by UMIST (now the University of Manchester), would also be served by the station.





Princess Street (or Whitworth) would have been built on the site of the present Whitworth House, with a direct link to the proposed major development north and east of the station, as well as serving the Manchester College site (formerly City College Manchester, previously Shena Simon College, and before that the Mather College of Education), UMIST, as well as other developments.

Albert Square/St. Peter's Square (or Central), serving the administrative and entertainment parts of the city, would have six entrances in St Peter's Square, together with a bus lay-by, part of a redesigned square. Albert Square would also be redesigned, with a concourse beneath the square, along with a direct link into the Heron House development and a travelator link to Oxford Road railway station.

Market Street (or Royal Exchange) would have lain beneath the junction of Corporation Street, Cross Street, and Market Street, directly linking into the Royal Exchange, Marks & Spencer, as well as the Arndale Centre.

Victoria Low Level would have a concourse below Long Millgate, serving the Co-operative HQ and the Corn Exchange. Development of the Picc-Vic would also allow the main line station to be rationalised and redeveloped, along with a proposed new bus station.

A prototype SELNEC interactive display board is now on display at the Museum of Transport, Greater Manchester.

Source: Wikipedia and Martin Dodge

## Water Towers with Deep Roots, Cologne

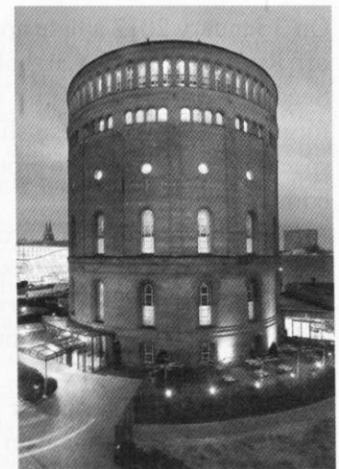
Julian Allason

The views from the Hotel-im-Wasserturm ('hotel in the water tower') must be the best in Cologne, the cultural centre of the Rhineland in western Germany. Built in 1862 on the highest hill in this fairly flat city it was – at 118 feet – the tallest water tower in Europe of the time and an impressive example of structural engineering with deep roots. It was used for almost 130 years to provide a large quantity of water under gravity pressure through an extensive network of deep mains until superseded by an underground canal system.

During WWII the tower was also used for anti-aircraft observation. That it was simultaneously employed as a refuge by civilians says much about the ferocity of Allied bombing of the city, from which 90 percent of the population were driven out, wounded or killed. Despite being listed as an historic monument in 1987, the by-now derelict structure was converted – ingeniously – by French architect/designer Andrée Putman into an elegant business hotel which opened in 1990 and remains locally owned.

The original brickwork has been preserved, creating an atmospheric interior, the old pump rooms now being used as the bar. On the 11th floor the hotel now has a two-Michelin-starred restaurant, La Vision, patronised by Brad Pitt who likened the hotel to Rapunzel's tower. It is certainly full of blondes. The kitchen also commands one of the best views in Europe including the Dom, Cologne's great gothic cathedral, which also miraculously survived WWII bombing. Guests with rooms or suites on the 8th, 9th and 10th floors enjoy glass walls and may circumnavigate the walkway. An idea of the comfort levels may be gleaned from Hotel-im-Wasserturm's affiliation to Small Luxury Hotels.

Beneath the ground-floor hotel lobby are the subterranean floors, not open to guests, used for storage and utilities, and subject to careful monitoring for structural integrity. The foundations are necessarily deep – no one is now quite sure how deep, but miners were employed in the construction. They are also of necessity wide given the issues of top-weight and stability, the location being close to the Rhine.



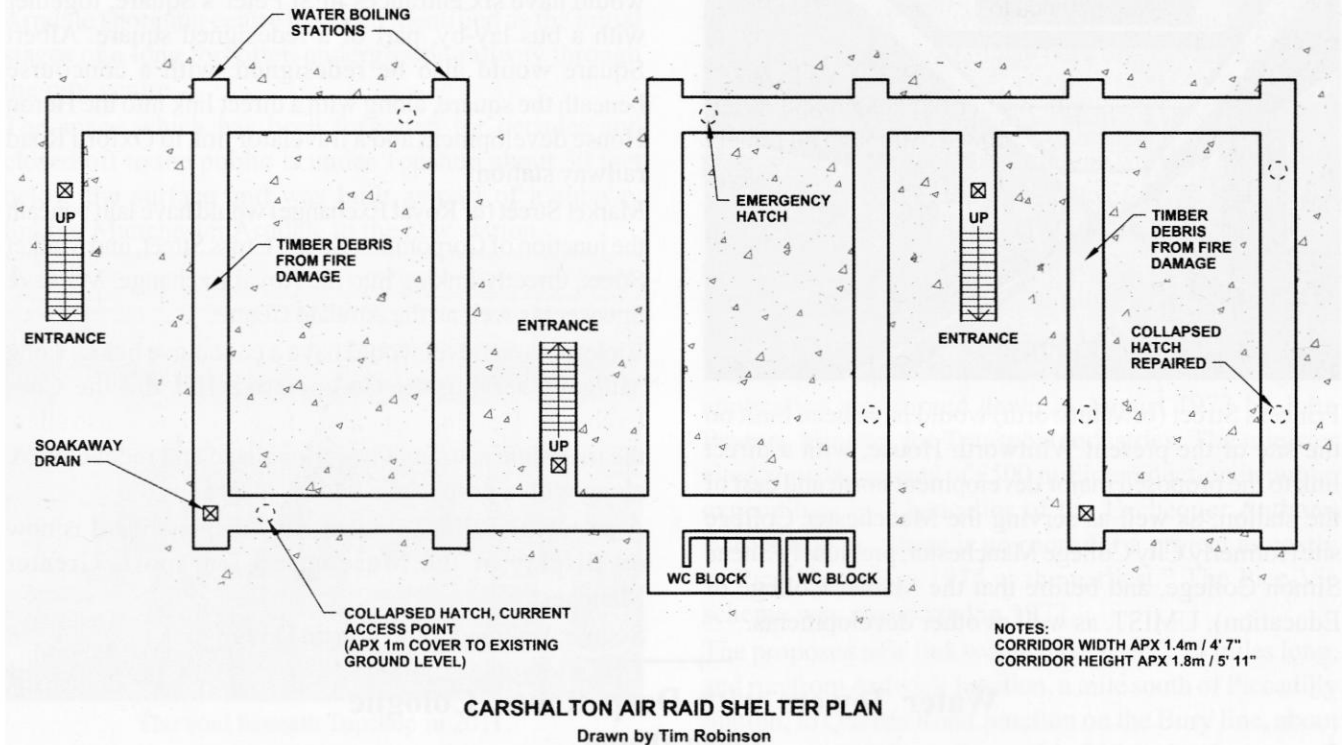
Some of the original large-bore pipes survive and have been reused as cable ducts in certain parts of the city, although the connections to the tower are understood to have been removed during underpinning works and the construction of a restaurant and banqueting suite adjoining the base at ground level.

A similar, though later, water tower in Hamburg has more recently been converted into a 14-storey hotel run by the Swiss group Movenpick. Even taller is a gothic water tower in Warsaw, Poland which rises to 203 feet (62m). It has been converted into the Restauracja Wieża Cioenień and serves traditional Polish dishes like *Pierogi* (dumplings of unleavened dough), appropriately a favourite among miners who also worked on its construction.

<[www.hotel-im-wasserturm.de/en/aboutus.htm](http://www.hotel-im-wasserturm.de/en/aboutus.htm)>

## Carshalton Air-Raid Shelter, Surrey

Ed Combes



On 3 January 2012 a hole appeared in Carshalton Park, off Ruskin Road in Carshalton, that revealed a large Second World War air-raid shelter that had long been forgotten. Many of these shelters were built in public spaces in the Southeast to protect the public from German bombing raids.

Air-raid shelter policy and provision is an enormous topic and is not going to be addressed in this article, as it has been well covered in *Subterranea* and elsewhere. This article looks at the construction style, layout and provision within this particular shelter.

From the outside the shelter is not noticeable – there is barely a hint of a mound in the grass and no obvious signs of the old wartime entrances or emergency exits, these having been filled and sealed many years ago. It is possible to see scorch marks in the grass at these coordinates 51.362443, -0.162258 (via Google maps) that give a hint that there might something underground. There are no other surface features visible at all, apart from a very slight rise or mound to the north of the park.

The shelter itself was constructed by the cut-and-cover method; this is where the site for the shelter is excavated and the shelter constructed in the hole, then covered over again with the spoil. The presence of the slight mound at this site would support this. The shelter had three walk-in stairway entrances and five emergency exits and was built in a ladder pattern with two long corridors joined together with five cross-passages; there were three entrances, one at one end, one on the middle area and one at the far end. There were both male and female toilets but no evidence of first-aid or 'kitchen' areas

although this is hard to ascertain as the shelter is essentially empty tunnels.



The timber seen in this corridor is probably the remains of benches. Photo Paul Naylor

The construction design consists of a concrete floor within which is embedded a steel framework made from 'L' section shaped-metal formwork. There are uprights approximately 1.8m high that are joined to their adjacent neighbours by more 'L' section metal work approximately 1.5m in length. These are further joined to their opposites on the other side of the passage by more 'L' shaped metal work. The end result is a tunnel-type metal framework with the sections all linked to form a solid structure.

The metal work appears to be embedded in the concrete floor as the bases of the metal uprights have bolts that are half-covered in concrete. Whether there are metal

joiners between the feet of each upright is unclear but it would be safe to assume there are as in a number of places it is slightly visible. The metal work is all joined together with between four and six large nuts and bolts with a bracing plate for rigidity. The metal work appears to have been painted with primer red at some point but they are now quite heavily corroded. Although all remain intact, this style of metal framework continues throughout the entire shelter with the exception of three areas. The entrances are poured concrete, the alcoves with the stoves are also just concrete, and the toilet areas appear to be rendered brickwork.

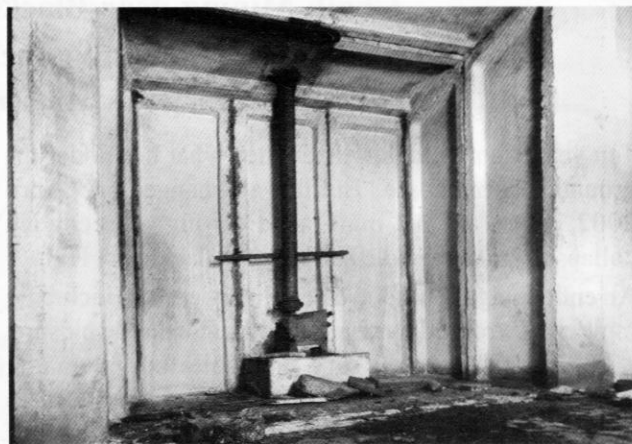


Toilet cubicles. Photo Paul Naylor

Surrounding this metal 'cage' are concrete sections; the wall sections are approximately 1.8m high and approximately 0.3m wide with a small recessed area 5cm deep from about 5cm in from the edge all the way round – this is presumably to save weight and raw materials without sacrificing strength. The roof sections are the same width (0.3m) but are slightly shorter at about 1.4m. This makes the tunnel higher than it is wide and the concrete sections appear to be cemented together. The corridors are all approx 1.4m wide by 1.8m high. In the entrances the concrete sections give way to what appears to be poured and shuttered concrete although this was hard to inspect due to infill material.

The shelter appears to have had a number of main entrances and several emergency exits. The main entrances all showed evidence of wood framework, perhaps for internal doors or gas curtains. The emergency exits consisted of a metal ladder bolted to the wall leading up to a round tube on top of which was originally an air-raid shelter emergency exit hatch. Evidence of a broken hatch was found in a pile of rubbish in one corner – the fragment was similar to other extant examples seen.

All emergency exit hatches had been sealed with concrete. Throughout the shelter there was evidence of electric lighting, with light fittings (wire-framed bulb guards) switches and wire all evident throughout most parts of the shelter. The electrical fittings were fixed to pieces of wood that were then affixed to the metal framework. At various points (approx eight in total) there was a small stove on a concrete plinth for boiling water, with a chimney extending through the roof at each one.



Carshalton 3 One of 8 stoves in an alcove at the end of a corridor. Photo Nick Combes

The shelter also had toilet provision for men and women; the male toilet was a urinal and two cubicles while the female toilet had five or six cubicles. The toilets were connected to a drainage system with a manhole in the toilet block. There was air-vent ducting present in both toilets. In one end of the shelter appeared to be a large drain or well, approx. 60cm wide and 1.20m deep but backfilled. Its purpose was unknown, but it was nicely constructed in a beehive fashion from bricks with a metal grille covering it.

Throughout the shelter there were various numbers stencilled on the walls but they appeared to bear no relation to each other as they weren't in a logical order; there was also evidence of a shelter regulations sign but this was very worn and barely readable. In various places there were piles of rotten wood, and one passageway was covered in about 15cms of rotten wood – purpose unknown but presumably benches or bunks.

This large shelter was generally in good condition although water has penetrated at several points causing corrosion of the panel joints and cracking of the concrete. There is no sign of vandalism, however some very modern rubbish (soft drink cans, discarded batteries and the like) has appeared in the entrance area from visitors after only a few days.

The council has now installed a lockable hatch to preserve the shelter after an earthenware bottle was stolen. Thankfully some local residents kindly donated an identical bottle from a private collection.

#### Sources

*Surrey Comet* 10 January 2012

<[www.surreycomet.co.uk/news/sutton/9460862.Forgotten\\_air\\_raid\\_shelter\\_discovered\\_in\\_Carshalton/Your\\_Local\\_Guardian.co.uk](http://www.surreycomet.co.uk/news/sutton/9460862.Forgotten_air_raid_shelter_discovered_in_Carshalton/Your_Local_Guardian.co.uk) 22 February 2012>

<[www.yourlocalguardian.co.uk/news/local/suttonnews/9545403.Air\\_raid\\_shelter\\_raided\\_by\\_overzealous\\_WWII\\_enthusiasts/Sutton\\_Guardian](http://www.yourlocalguardian.co.uk/news/local/suttonnews/9545403.Air_raid_shelter_raided_by_overzealous_WWII_enthusiasts/Sutton_Guardian) 8 March 2012>

<[www.suttonguardian.co.uk/news/9574300.Bottle\\_donated\\_after\\_air\\_raid\\_shelter\\_theft/Britain\\_at\\_War](http://www.suttonguardian.co.uk/news/9574300.Bottle_donated_after_air_raid_shelter_theft/Britain_at_War), Issue 58 – February 2012>

Report for Sutton Council by Richard Wyatt, Assistant Park Manager

## Chalk Mining near Blackheath Hill, southeast London

### Including Jack Cade's Cavern

Anthony Durham

Ten years ago I had very little idea what lies under the ground near my home. But that all changed on 7 April 2002, when the A2 main road through Greenwich collapsed into a big hole halfway up Blackheath Hill.

An entire neighbourhood of small businesses (including mine) was wrecked by nine months of total road closure, with much human misery and collateral damage. Suddenly it became a matter of economic life or death to understand our local geology and the causes of subsidence. Telling this story now may help other areas escape a similar fate in future.

Greenwich is in southeast London, but historically it was part of Kent. It grew up where the ancient main road from London to Dover just grazes the south bank of the Thames, and where the river Ravensbourne flows in from the south towards Deptford Creek. Steep hills rise from Greenwich town centre, and from the Creek, up towards the flat, stony plateau of Blackheath. For centuries those hillsides have served as a source of building materials, especially chalk, conveniently positioned for transport by water to the City of London.

#### Holes everywhere

Greenwich is a World Heritage Site, where tourists come to gawp at grand buildings: the Observatory, Maritime Museum, Old Naval College and much more. However, on a world scale, Greenwich and its surroundings are even more remarkable for what is under the ground. No other place on the planet can match this area for sheer diversity of odd holes: tunnels (for trains, cars, pedestrians, sewage, fresh water and utilities), mines and quarries, archaeological remains, wells, weird basements and hollow pavements. We even have some of that staple of popular imagination – underground escape routes out of grand houses.

When I started digging into local history, surprises came thick and fast. For example, it seems that Watling Street (part of the ancient strategic road from Rome to Anglesey) ran right past my home in downtown Greenwich, heading for the mouth of Deptford Creek and Westminster.

Nowadays the A2 main road crosses the Creek a mile to the south, which takes it right past my shop at the bottom of Blackheath Hill. The explanation for the shift south is probably that sea levels have risen by about four metres relative to the land around here since Roman times.

Blackheath Hill is part of the A2 main road, actually one of the steepest trunk roads anywhere in southeast England, leading up to the vast open space of Blackheath. It really ought to be famous as the site of the closest proper land battle to London. In the 1497 “Battle of Deptford Bridge”, Cornish rebels somehow failed to hold

the high ground or the bridge across the river against the troops of King Henry. History might have been very different if they had had a few cannons or some cavalry.

#### Jack Cade's rebellion

Blackheath has long been a favourite place for revolting peasants to gather. Nowadays people come to fly kites, visit the circus and run marathons, but on at least four occasions large rebel armies have camped on Blackheath as a base for attacking London. They gave the English language some of its most famous rallying cries of the underdog, such as “When Adam delved and Eve span ...”, attributed to the Peasants' Revolt of 1381. And Shakespeare's memorable line “First let's kill all the lawyers” is set on Blackheath during the 1450 rebellion led by Jack Cade. His name was actually just a *nom de guerre* and he met the usual sticky end of rebel leaders, but never mind – we shall meet his name again.

Blackheath has remained open ground over the centuries because it is so infertile. Basically it is just a thin coating of topsoil over a vast prehistoric bank of shingle, through which rain drains very fast, leaching out calcium carbonate and trace nutrients. So it is not good for arable crops and was used for centuries as a place to dig gravel. Many old gravel pits were filled in with wartime bomb rubble, but even now a formidable number of man-made holes survive around the edges of the flat grassy area and also inside the adjacent Greenwich Park.

From 1878 to 1880, a succession of very deep holes abruptly appeared in Blackheath, which were investigated by an 1881 committee of local bigwigs. Then after 1900 some huge underground voids were encountered while tunnels were being bored under the heath (for trains and sewage), but they were not properly recorded.

Much the same happened in tunnels lower down near the Thames for the railway line from Greenwich to Woolwich – more mystery voids not properly recorded. Throw in a couple of mysterious subsidences inside Greenwich Park, plus various holes further away in the Borough of Greenwich, and one can confidently say that Blackheath is a bit holey.

#### Deneholes and chalk mines

Some underground voids might be natural caves, a possibility much discussed by the 1881 committee. Chalk is inherently full of cracks and fissures, and is just as soluble in acidic rain as the harder rock usually called limestone. However, nowadays one would guess that most of those subsidences were due to deneholes.

All over southeast England vertical shafts were dug in the middle of fields or at their edges, most likely during the period of warm climate and population growth before the 1348 Black Death, when more land was being put to

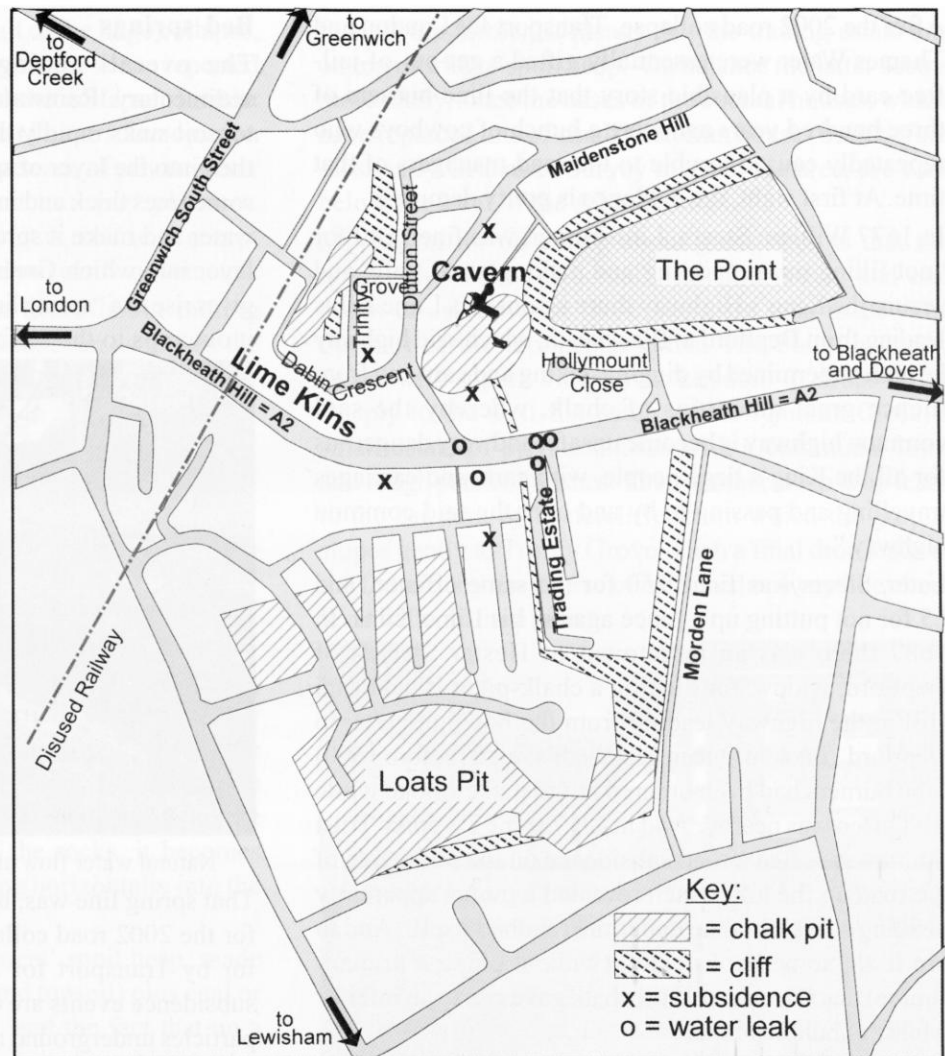


the plough. Chalk was mined at the bottom of the denehole, hauled to the surface, then spread on fields. This raised the soil pH and added trace nutrients, thereby increasing crop yields. Disused deneholes used to be plugged with tree stumps and covered over, ready to mystify folk centuries later if the plug gave way and the shaft collapsed.

In short, the earliest substantial holes in and around Blackheath probably went straight down, as deneholes looking for chalk. Another classic vertical hole is a well for water. However, most people lived down near the Thames, and if they wanted clean water it was better to dig horizontally, into the side of the hill. So Greenwich Park is positively riddled with conduits, some of which are substantial brick-lined tunnels running for hundreds of metres into the hillsides. Sir Christopher Wren probably supervised the construction of the best-known conduit, which channelled water towards the grand buildings where royalty relaxed, retired seamen lived out their days, and aspiring seamen went to school.

After learning so much about Greenwich underground, I started offering guided tours of where the holes were and what they did, but the local tourist office refused to give out my publicity leaflets, because I do not have an NVQ in tourist guiding! So my plans for an informative website got stymied, but about then a veteran underground explorer, Per Scheibner, started up <http://subterraneangreenwich.blogspot.co.uk>. That is an excellent place to look online for photos and information beyond my text here.

The number-one source before Scheibner was a 1973 article by Harry Pearman in volume 6 of the Records of the Chelsea Spelæological Society. Before him, John Stone wrote a key article in 1904. A thick dossier kept by the Greenwich Heritage Centre has most of the key documents and photos, plus newspaper microfilms, while original documents are in various archives, notably at Morden College, beside Blackheath. I shall try to angle the account that follows away from what Scheibner and others have made readily available and towards correcting some of the inaccuracies that fester on the internet.



The whole area around Blackheath Hill, showing modern streets, known areas of excavation in the past, approximate sites of ground collapses, and steep "cliffs" which may be partly man-made

The Greenwich area is more pock-marked with craters than the surface of the moon, though they are disguised by houses and vegetation. All that digging was not for any of the high-value minerals that Britain has historically been famous for (coal, copper, tin, lead, oil), but just for building materials conveniently close to London. Steep hillsides such as Blackheath Hill offered good sites for mining chalk to be burned into lime, which was taken on a short cart ride to Deptford Creek and then shipped by water to London.

#### Help from old maps

Old maps indicate roughly where the lime kilns used to be. Modern Greenwich South Street was once Lime Kiln Way, and a whole district around its junction with the A2 was called "Lime Kilns" even as late as the mid-1800s when public records started becoming fairly reliable. However, trying to pin down the exact kiln site(s) is difficult. A 1697 map by William Travers suggests they lay between Dabin Crescent and Blackheath Hill, where now there are some unexciting blocks of council flats. It is a humbling experience, which inspires great respect for ancient and modern surveyors, to try to reconcile old and new maps, and to represent a 3D landscape in 2D.

After the 2002 road collapse, Transport for London and Thames Water were essentially gifted a get-out-of-jail-free card by a plausible story that the lime burners of three hundred years ago were a bunch of cowboys who repeatedly caused trouble to the road managers of that time. At first sight, the evidence is pretty damning.

In 1677 William Steers, Limeburner, was fined £40 for “not filling up, supporting and making good, safe, and secure the King’s Highway there against his Lime Kilns leading from Deptford to Blackheath, which said highway he hath undermined by digging, taking and carrying from thence great quantities of chalk, whereby the said common highway is become unsafe, and very dangerous for all the King’s liege people, with carts and carriages travelling and passing in by and over the said common highway.”

Later, Steers was fined £50 for the same offence, and £5 for not putting up a fence against his Lime Kilns. In 1687 there was an indictment of Hester Steeres of Deptford, widow, for digging a chalk-pit at Blackheath Hill in the highway leading from the bowling green to Deptford. Back in Queen Elizabeth’s reign (before 1600) lime burners had been ordered not to make smoke while the Queen was nearby. And in 1797 some Turnpike Trust minutes reported a road subsidence on the north side of the road up the hill, which revealed a tunnel apparently heading some distance under the roadbed itself. And to top it all, some books claim (without citing a primary source) that Blackheath Hill chalk gave rise to an inferior quality of building lime.

Per Scheibner suggests that our whole local area is riddled with underground cavities just waiting to collapse under the innocent traveller. I am more inclined to stand up for those old lime burners near Greenwich, whose engineering and managerial skills, and respect for the local community, should not be under-estimated. Maybe I am biased, since some of my own ancestors back then were local boatmen, who might even have earned their living transporting lime up to London.

One can imagine the Steers family earning their living for generations on a patch of hillside that nobody much cared about, selling lime for rich people to build houses down by the Thames near the Palace of Placentia. Then business boomed after the Great Fire of London in 1666 and even more when the Naval College began in 1694. That 1697 map mentioned above was actually prompted by a legal dispute between the Crown, which owned Greenwich Park, and the newly founded Morden College, which owned much of the rest of the land near Blackheath Hill. Even the most responsible miner might find it expedient to burrow secretly underground rather than excavate visibly on the surface if it was not really clear who owned the land. However, all that would be mere speculation based on inadequate information. We need to look for more evidence.

## Bed springs

The overall geology of the Greenwich area is sedimentary. Rainwater falling onto Blackheath’s thin topsoil sinks rapidly through its underlying gravel, and then into the layer of sand, where there are beds of clay, sometimes thick and impermeable enough to hold up the water and make it spread sideways. This forms the wet layer into which Greenwich Park conduits tapped, and gives rise to a “spring line” part-way down hillsides, where it outcrops to the surface.



Natural water flow at the spring line on a nearby road

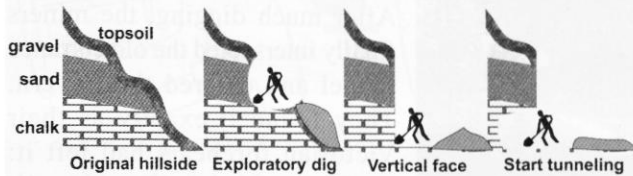
That spring line was, by implication, the culprit blamed for the 2002 road collapse in a consultants’ report paid for by Transport for London. It explained that most subsidence events are caused by water transporting soil particles underground and opening up ever-bigger voids, which finally collapse.

Unfortunately the report did a rotten job on the specific conditions of Blackheath Hill, where the subsidence happened after a very dry spell (so no recent rain) and just downhill from some dry vertical walls (so no chronic water flow). In fact the subsidence happened just downhill from the sites of at least three water leaks from water mains during the previous five years, and across the road from a pub that had been abandoned after water-caused subsidence.



The 2002 big hole in the A2 carriageway, with a broken water main in its middle. Photo John King

Allegedly the pipe broke as a result of the huge collapse, but several people who were early on the scene reported that fast water leakage preceded the collapse. It must be pretty clear from this article that I have a low opinion of the ethics and engineering competence of private water companies and local government transport planners. However, my general point is that it is unwise to accept passively what officialdom says about earth movements. It seems that little is known in detail about mining techniques used around Blackheath, even as late as the 1800s.



A simple-minded view of how ancient miners might have dug for chalk in a hillside

While digging into a hillside without modern machinery, miners will tend to create a vertical cliff or quarry workface with a horizontal area in front that is partly the floor of the digging and partly the top of a spoil heap. In due course, when the miners understand the strata, the water table, and the strength of the rocks, it becomes rational for them to start burrowing horizontally into the chalk.

Notice the importance of the miners' spoil heap, made up of overburden (sand, gravel, and topsoil) plus coal or wood ashes from the lime kilns, and the fact that on a hillside it gets naturally tipped down a slope. Notice also how chalk, the main target of lime burners, can be quite dry in a hillside, being below the spring line but above the deeper water table.

It follows that mining tended to transform hillsides from their natural fairly steady slopes with gullies into one or more steps or terraces. Experienced mining geologists or archaeologists may be able to intelligently interpret much better than I can what old miners were aiming for around Blackheath Hill, but here I just want to draw attention to the multiple steps that still exist in the landscape.

### Steep steps

On the Lewisham (south) side of the A2, the Lethbridge housing estate sits in a huge crater, which used to be called Loats Pit. I have not unearthed much information about this Pit, but Ordnance Survey maps show that it was active in the mid-1800s. Around much of its south and east edge there is still a steep cliff, albeit nowadays covered with soil and vegetation, plus danger-keep-off signs. The really interesting part is that towards the northeast, instead of a single cliff there are two giant steps, one below Morden Lane, the other below the Blackheath Trading Estate.

I do not know if it was specially constructed to make a terrace or if it represents the remains of a working quarry

face. If the former, it means that the trading estate sits on top of a huge spoil heap. On balance the latter seems more likely, since the bases of the council houses, which have replaced lots of small Victorian houses built before most early Ordnance Survey maps of the area, are well below the level of the A2 main road.

My reason for obsessing about giant steps is that the north side of the A2 actually has four steps, and one needs to ask how far those steps are man-made. The flat part of the top step is called The Point, a grassy sward with superb views over London. It drops down steeply to the next flat patch, of Hollymount Close, a small estate of private houses with a communal lawn and rough patch of bushes. Then another steep drop leads to the car park of Undercliffe from which the ground slopes gently to Trinity Grove. Then a final drop leads to the flat area by the course of a disused railway line about level with old lime kilns.



Looking into the car park of the Undercliffe flats. Its back left is close to the old entrance to Jack Cade's Cavern.

No one seems to know how far the abrupt transition from vertical to horizontal was man-made

Cross-hatched areas marked as "cliff" on my main map can indicate vertical walls of brick or concrete, or steep banks of mud and vegetation, or combinations of both. The actual drop is often very substantial, equivalent to several storeys of a house. It is noteworthy how the line of the big brick wall south of the A2 continues north of the A2 as the back-wall "cliff" of the Undercliffe flats, which occupy the former site of Holy Trinity Church. Presumably that line results from geology and not some dark-age defensive dyke protecting Kent from London! The best known cavity in the area is Jack Cade's Cavern, manifestly an old chalk mine, but of unknown date and nothing to do with Cade the rebel leader. You can read in places that it lies underneath the top step (The Point) but that is wrong. It actually lies mostly underneath the grounds of Hollymount Close, whose residents should be congratulated for refusing suggestions to fill up the Cavern with many lorry-loads of grout. (So please don't pester them in search of their underground cavity.)



In the autumn of 1938 Greenwich Council hired some Durham miners to sink a shaft in the garden of 77 Maidenstone Hill, in the hope of finding the lost cavern. Presumably this photo shows those miners plus the Council's sleuth, Mr Craske. Photo from the Greenwich Heritage Centre

“twenty paces east of the old pear tree” and “in line with the centre axis of the church”. Poring over old maps, earth electrical resistance measurements, and even a dabble with divining rods, finally emboldened Craske and the Council purse-holders to hire professional miners to sink a shaft in the garden of 77 Maidenstone Hill.

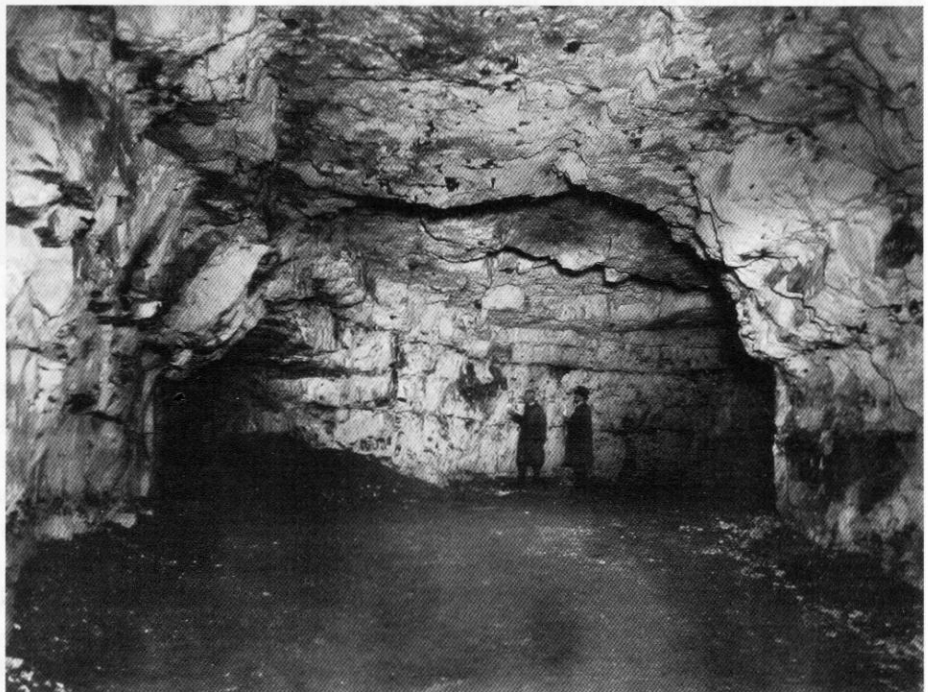
After much digging, the miners finally intersected the old entrance tunnel and entered the Cavern. They found it exactly as their Victorian forebears had left it: graffiti, old bottles and all. Unfortunately the Cavern and its entrance were too small for use as an air-raid shelter, so it was temporarily shut up until in 1946 the Council decided to shut it permanently. However, before then the Cavern was carefully surveyed

### Lost and found

Jack Cade's Cavern has led an eventful life over the centuries, having been lost, found, lost, found, and lost. Between 1780 and 1853 it was open to the public as a show cave, rather like Chislehurst Caves today. Unfortunately, in 1839 Holy Trinity Church was built right next to it and a masked ball in the Cavern in 1852 caused such a scandal that the public were excluded and the entrance was blocked up. Just imagine what today's Health and Safety people would say about a rave-up in an underground venue with poor ventilation, uncertain structure, and only one exit!

After that the Cavern faded into oblivion, with its entrance obliterated under the Victorian terraced row along Maidenstone Hill. Then in 1906 archaeological/tourist interest spurred Greenwich Council into trying to reopen the Cavern, but they could not find it. Nor again in 1914–18, even spurred by the threat of Zeppelin bombing. However, in 1938, the looming Luftwaffe made the Council try harder.

The Borough Engineer's assistant, Mr C W Craske, threw himself into hunting for the cavern. Old maps and the memories of old-timers led him on a fascinating trail:

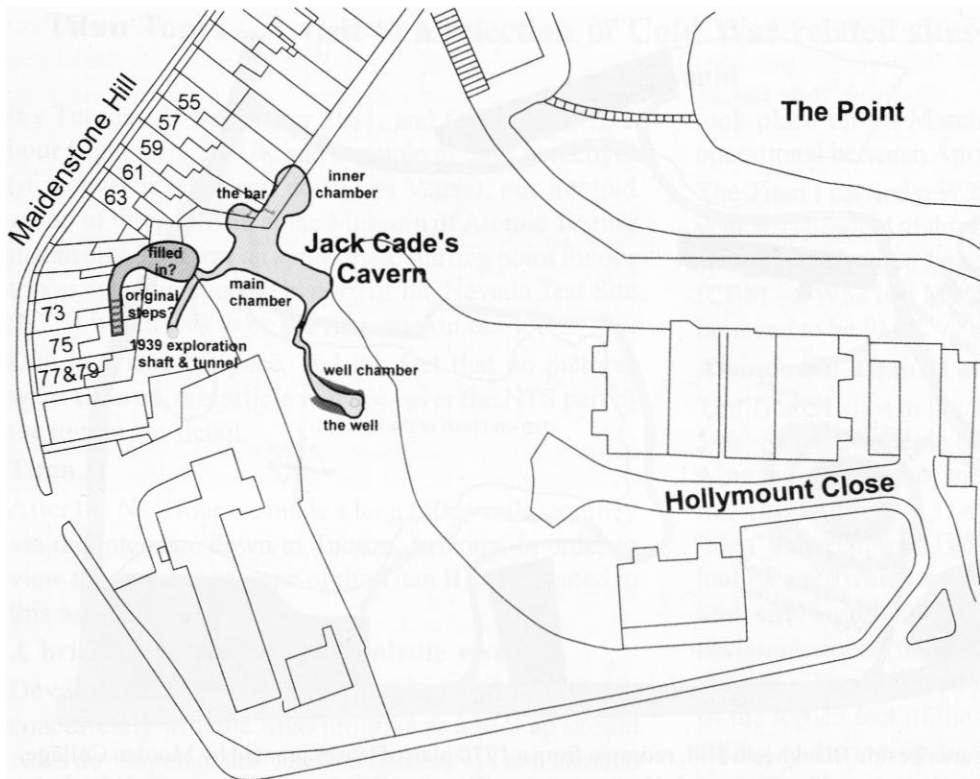


Photograph taken in the main chamber of Jack Cade's Cavern in June 1946 just before it was sealed up, and now kept in the Greenwich Heritage Centre. One of the men in the photo might be the Borough Engineer, Charles Jennings, or his assistant C W Craske. Hats off to the local bureaucrats of yesteryear! Photo from Greenwich Heritage Centre

and photographed, and Per Scheibner has posted those photos online.

In some rough ground at the northwest corner of the lawn of Hollymount Close, a rusty metal pipe, covered in ivy and clogged with earth, sticks up a metre or so. Presumably this is a ventilation shaft left over from WWII,

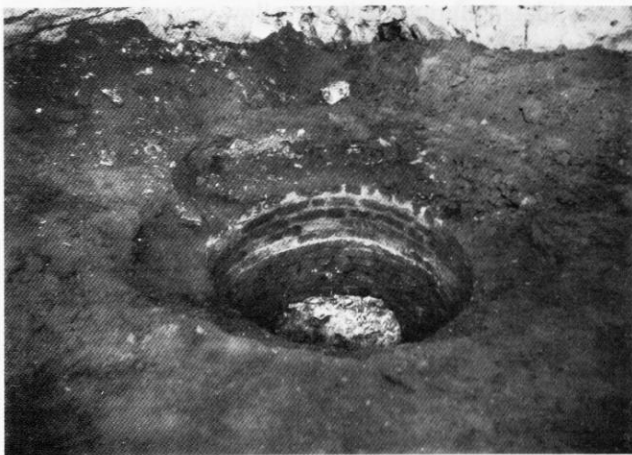




A map showing exactly where the Cavern lies relative to modern houses, a public walkway, and the private shrubbery of Hollymount Close

down which a modern remote-inspection video camera could in principle be sent. One can stand on top of the Cavern by walking up a little footpath, entered from Maidenstone Hill or The Point, and either peer at the greenery hiding the pipe, or observe back gardens far below that also overlie parts of the Cavern.

Allegedly the Cavern was discovered by accident in 1780, by a builder digging foundations for a house. Then someone created a proper entrance through a cottage, probably situated near the end of a garden between today's 69 and 75 Maidenstone Hill, with a flight of forty steps leading down into a complex of five or so chambers. Old accounts describe anywhere up to seven distinct chambers as originally discovered, in contrast with the



This well lies at the end of a short tunnel away from the main chamber of Jack Cade's Cavern. It, and the whole Cavern, were bone dry when photographed in 1946.

Perhaps it was just a shaft going down to investigate the quality of the chalk there.

Photo from Greenwich Heritage Centre

three surveyed by Craske and colleagues, a difference that may partially reflect removal of internal subdividing walls. However, a crude 1790 plan suggests that there was one more chamber at the entrance, which was blocked up during the 1853–54 sealing-up.

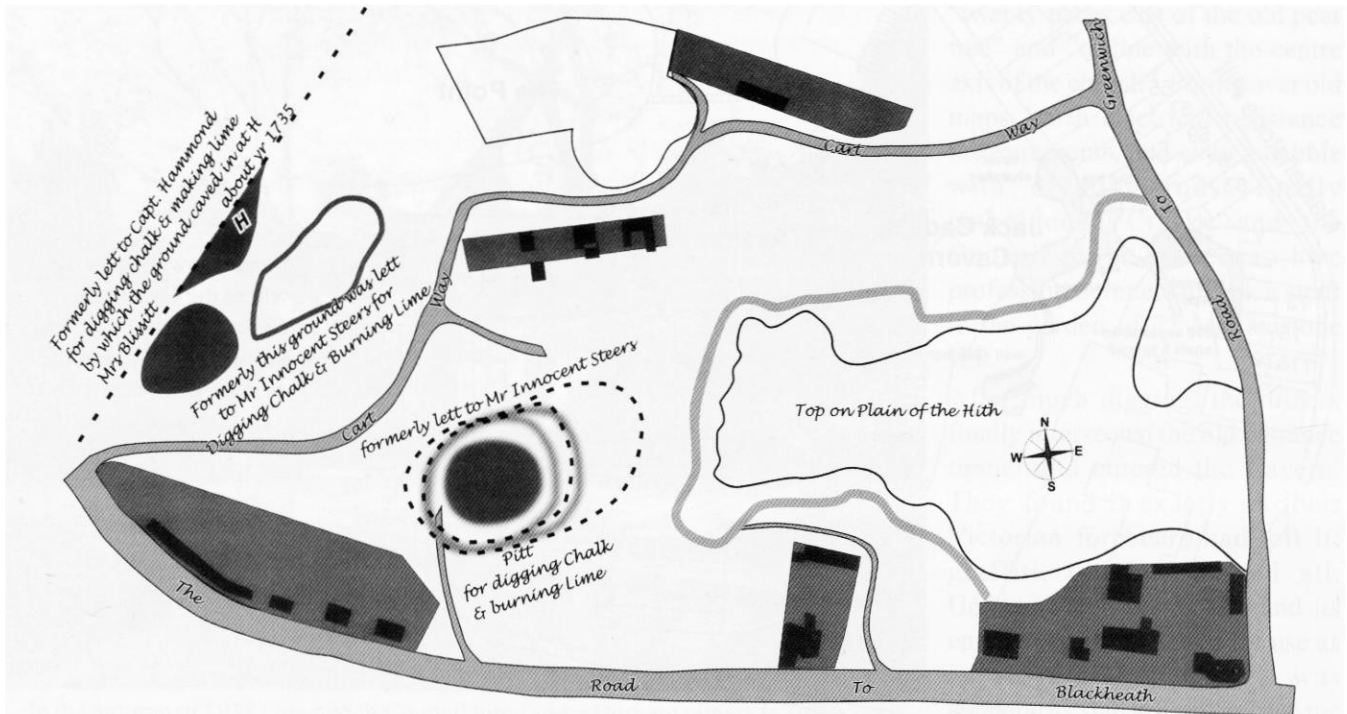
#### Burning lime is productive

I can believe that that 1780 builder did not expect to find the Cavern, but it is simply not credible that no one then alive knew it was there. A map from Morden College archives shows an area marked in the right place as "*Formerly let to Mr Innocent Steers, Pitt for digging chalk & burning lime*". That lease expired in 1734, and the life of Innocent Steers from birth in 1697 to death in 1770 is charted by records of St Alfege parish church. His parents "*Thos & Ann limeburner*" seem to have produced twelve other children, some of whom left local descendants up to 1820, who formed a significant fraction of Greenwich's population of 5,400 souls.

Much more information about the Steers family remains to be extracted from the Morden College archives, and from other parish records around Britain, but what makes them particularly intriguing is that in Liverpool, one Thomas Steers (originally from Kent) became eminent enough to merit an entry in Wikipedia as "England's first major civil engineer".

I would love to imagine that Blackheath Hill was the real nursery of British civil engineering, just as scruffy old Deptford is under-appreciated for its roles as nursemaid of the Royal Navy and of the chemical industry.

That map from Morden College also shows a second area leased to Innocent Steers. It is hard to place exactly, but probably began right beside his lime kilns, where nowadays there is a sloping patch of grass



Map of the historic chalk-mining area beside Blackheath Hill, redrawn from a 1770 plan of leases granted by Morden College. The original is a colour-washed drawing now in the Greenwich Heritage centre. Despite all the practical issues (faded colours, altered roads, mapping conventions, etc) this map fixes the positions of three chalk-digging concessions to within a few metres. Two were operated by Innocent Steers, probably in the 1720s. The third mentions a mysterious Capt. Hammond

Then it extended north into an area that is now occupied by a sort of tennis court where boys play football over the path of the old railway line. Several residents of Trinity Grove seemed touchingly little concerned when I explained how the likely mining strategy outlined above probably means that Jack Cade's Cavern had a little brother underneath their houses! In fact, I would now guess that the much bigger drop from Dutton Street to the tennis court is more likely to be an old workface and possible start-point of a tunnel into the hillside.

So where does all this leave the vexed question of subsidences near Blackheath Hill? On the whole, I think



This innocuous patch of grass, plus the area behind it and to the left, is probably what remains from the Steers family's other chalk pit. No one knows if they tunnelled into the hillside to create a little brother of Jack Cade's Cavern

that subsidence is a bit of a red herring. Water is the lubricant of ground movement par excellence, and poorly maintained high-pressure pipes are a more troublesome source of water in a modern urban landscape than rain. When I tried to track down the site of the Maidenstone Hill subsidence in September 1897 mentioned in the last issue [*Subterranea* 28, page 72], residents were quick to mention leaking pipes and inadequate foundations, not cavities underground.

However, flowing water also needs somewhere to flow to – a sink as well as a source. Near here the sloping, porous ground, which may sometimes just be imperfectly consolidated mining spoil, can allow water to seep away unnoticed. Yet the really big problem arose because no one had the brains to read the landscape and to recognise the danger from some highly visible leaks.

### Conclusion

This article has been a painful reminder of my own ignorance. Much remains to be extracted from historical records and my maps need upgrading. Blackheath Hill is a whole landscape of industrial archaeology, conveniently situated in Greater London, and just waiting for some real geologists and mining engineers to tramp around and work out what would have been dug where. They might even be able to predict the location of an unsuspected centuries-old cavern – preferably before a bus or a building falls into it.

All recent photos taken by Anthony Durham unless stated. Maps and plans drawn by Anthony Durham.

Anthony Durham, 44 Roan Street, Greenwich, SE10 9JT

## Titan Tours – A visit to a selection of Cold War related sites in the western USA

Alex Gould

It's Tuesday 20 September 2011, and following a 10.5 hour flight from the UK and a couple of days to recover (if recover is what you do in Las Vegas), our intrepid group of three arrived at the Museum of Atomic Testing in that city. This was an appropriate starting point for our trip as it documents the history of the Nevada Test Site (NTS) which was to be the first stop on our tour.

Due to a lack of space, and the fact that no pictures were allowed, this article will not cover the NTS part of the tour in any detail.

### Titan II

After the NTS tour we made a long (400+ mile) journey via the interstate down to Tucson, Arizona, in order to view the remains of some of the Titan II sites located in this area.

### A brief history of the Titan missile system

Development of the Titan I began in 1954 and ran concurrently with the Atlas program as a backup should Atlas development fail. The first successful Titan I launch took place on 6 February 1959, and the missiles were deployed operationally for less than three years between April 1962 and February 1965. The Titan I was the first true twin-stage ICBM to enter service. Earlier ICBM designs such as the US Atlas and Russian R7 (Nato: SS-6 Sapwood) were 1.5 stage missiles. True two-stage designs result in a more efficient rocket typically with a higher throw weight. The Titan I was fuelled with Liquid Oxygen (LOX) and Kerosene (RP1) and was therefore unable to store the cryogenic oxidiser on board the missile. The need to fuel the missile prior to launch resulted in slow reaction times which led directly to the development of the Titan II.

Titan II was a direct development of Titan I, the primary change being the use of hypergolic propellants (Nitrogen Tetroxide and Unsymmetrical Dimethyl Hydrazine) which could be stored on board the missile, thereby reducing reaction time. The Titan I was deployed on a giant lift

which raised the fuelled missile (a weight of approx 200,000 lbs) to the surface for firing. The time required to lift the missile again meant a slow reaction time. Titan II solved this issue by being designed for in-silo launch, and was the first such ICBM to enter service. The first successful launch of a Titan II



Titan II ICBM being fired from its Silo at Vandenberg AFB, California

took place on 16 March 1962, and the missiles were operational between April 1963 and May 1987.

The Titan I carried a W38 warhead in a Mk IV re-entry vehicle. The yield of this bomb is given as 3.75 megatons. Titan II carried the largest warhead deployed on a US ICBM – a W53 in a Mk VI re-entry vehicle. The yield is believed to be 9MT.

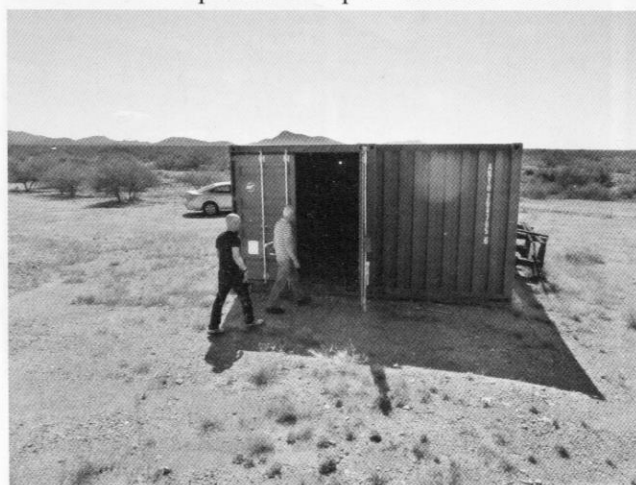
### Abandoned Titan II sites around Tucson

The Titan II sites in the Tucson area were all part of the 390<sup>th</sup> SMW (Strategic Missile Wing) of the USAF. The wing was made up of the 570<sup>th</sup> and 571<sup>st</sup> SMS (strategic missile squadrons). The wing had Titan II missiles on 'alert' between April 1963 and May 1984. Each squadron had 9x sites which were named with squadron number and site number e.g. 571-4. When the sites were decommissioned, they were destroyed in conjunction with the SALT 1 and 2 protocols. This involved the destruction of the top 25 feet of the missile silo, and its permanent filling and capping to prevent reuse. After the entry portals to the sites were filled in and all air shafts filled with concrete, the sites were sold off to local land owners.

Our first stop was site 570-2. This site had been comprehensively demolished, with the only surface structures being the fuel and oxidiser hard stands which would have been used to store the missile propellant trailers during fuelling, and various filled antenna and vent shaft caps. This was a good example of how little typically remains of these sites on the surface once they had been demolished.

Our next stop was site 571-8, operational between April 1963 and February 1984 and demolished on decommissioning. This particular site was interesting as the owner had excavated the access portal, thereby providing access to the Launch Control centre and blast lock structures.

Our entry point was via a pair of shipping containers which had been placed on top of the access shaft.

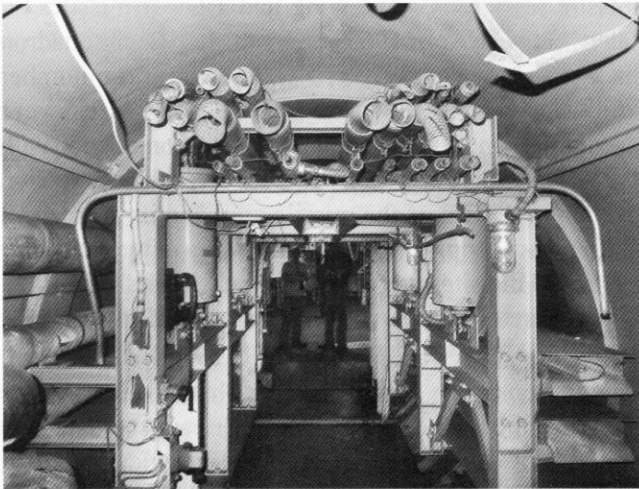


The two shipping containers used to cover the top of the access portal to the site

The access shaft was approximately 30 feet deep and completely devoid of the original stairs and lift. A ladder gave access to the foot of the shaft in front of blast door 6. This is the first blast door which makes up the 'blast lock' of four doors designed to protect the crew from external and internal explosions. Each blast door weighs approximately 6000 lbs, but they were so well balanced that it was possible to move them with little effort.

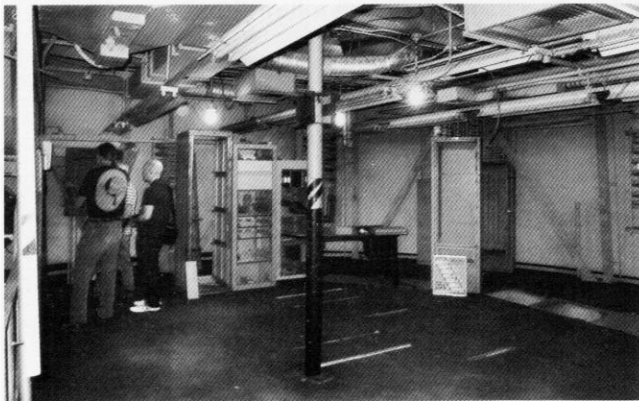
Passing through the blast lock we turned right into what would have been the access tunnel to the silo. The original tunnel or cableway was removed during demolition and a concrete plug placed in the opening.

Retracing our steps we headed down the short cableway into the launch control centre.



The short cableway. The structure in the foreground was used to carry cables and pipes towards the missile silo

The Titan II launch control centre is made up of a reinforced concrete cylinder 42 feet high and 37 feet wide. The upper storey consists of a domed roof 18 inches thick buried 8 feet below ground level. All three floor levels are shock-mounted on large springs to allow for vertical and lateral movement. The cableway enters the launch control centre at level two and this would have been the operations area with equipment to monitor the silo complex and monitor and launch the missile.



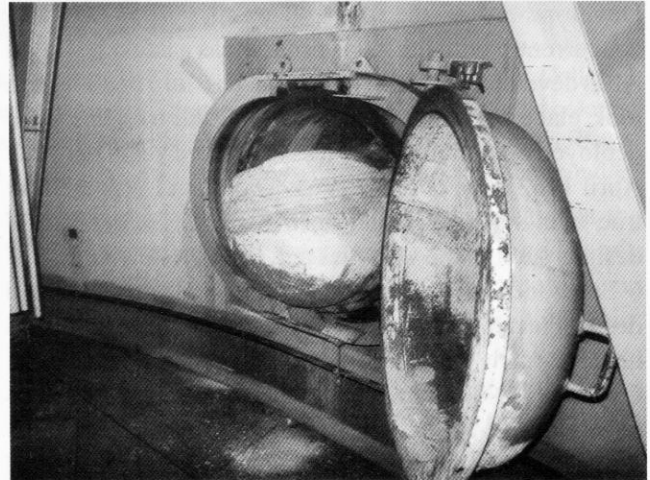
Level 2 of the LCC. The area to the right of the picture would have contained the equipment racks used to monitor and fire the Titan II missile. The location of the commander's chair and the launch console can be seen in the lines on the floor to the right of the pillar

Sadly all equipment including the launch consoles had been removed. However some equipment racks remained, along with a notice board giving original site-status information.

Next we headed up to level 1. This area would have been the crew's living quarters containing a kitchen, two-bunk bedroom and bathroom. The kitchen and bedroom were completely stripped; however the bathroom was largely intact complete with shower, sink and toilet.

Having had a poke around level 1, we descended to level 3. This area contained mainly communications, power supply and UPS equipment along with the sewage ejector station.

Most of the equipment racks on this level were still intact; some still contained equipment. This level also housed the emergency escape hatch which allowed access to the surface via the launch control centre air shaft. The door to the shaft was open revealing the concrete filling the shaft.



LCC escape hatch. When the site was decommissioned, the LCC air shaft was filled with concrete in order to prevent access

Having thoroughly examined level 3 we headed back to level 2 and out to the access portal via the blast lock. We then climbed the ladder back out to the 40-degree heat on the surface. Having briefly explored the surface remains, we headed to our next site, 571-9.

#### 571-9

Site 571-9 was interesting due to the fact that a large amount of soil had been removed from the site following decommissioning. This meant that a number of features which were usually buried were visible. After a brief explore of the antenna silo head works and the cliff under one of the propellant hard stands, the desert heat drove us back to the air-conditioned car.

#### 571-7

Our next stop in Tucson was the Titan Missile Museum at site 571-7 (2). Site 571-7 is the only preserved Titan II site and was operational between July 1963 and November 1982. To explore this site we had booked on one of the museum's 'Top to Bottom Tours'. This tour,

lasting from 08:30 to 13:30, gives an excellent look into all parts of the Titan II site including all levels of the preserved silo.

The tour and site have been well covered by Gavin Saxby in his article in *Subterranea* 25 (December 2010) so I will not go into detail about the tour. Particular highlights of the tour were sitting at the launch console, standing at the bottom of the silo launch duct, and hearing the Thunderbolt emergency siren tested on the surface.

**Titan I**

Having completed the top to bottom tour, our itinerary took us on the long drive back to Las Vegas in order to catch a flight to Spokane in Washington state for the next leg of our Titan tours, arriving in Spokane on 25 September.

**568-C: Silo swimming**

The first Titan 1 site on the list was site 568-C (3). This was one of three operated by the 568<sup>th</sup> Strategic Missile Squadron based at the now defunct Larson Air Force Base near Moses Lake, Washington. The squadron had 3x sites and was operational for less than two and a half years between September 1962 and January 1965. This particular site is located approximately three miles west of Royal City, Washington. After a long (135 mile) drive from Spokane, and breakfast at a local diner, we set off to explore an example of the most impressive of all the US ICBM silos.

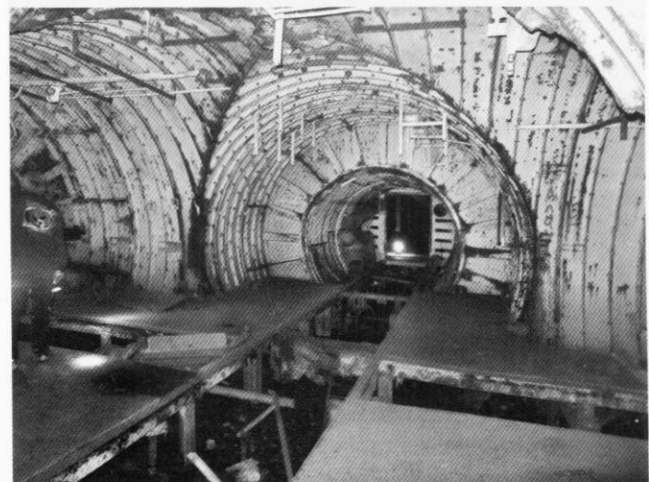
Titan I was deployed in a 3x3 basing model. That is 3x sites per squadron with 3x missiles per site. Each site consists of 3x missile silos which are 50 ft wide by 160 ft deep. Each silo has an equipment terminal and a propellant terminal associated with it. The sites also contained an underground power house, a launch control centre and 2x guidance antenna silos.

Each leaf weighs around 115 tons. After we had climbed on the doors and inspected the massive hinges, it was time to enter the relatively dry half of this site.

Entry was via the original main access portal. This consisted of a pedestrian access complete with blast door propped open by a rather dubious looking piece of wood, and a large freight lift accessed by another pair of large concrete doors.



The original personnel entrance to the site, with dubious wooden support

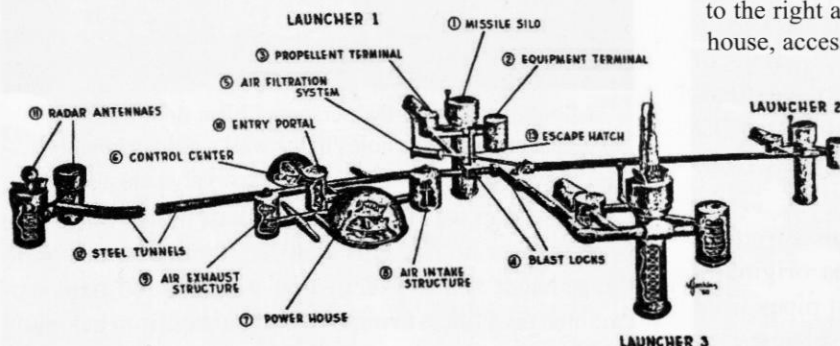


The main tunnel junction. The control centre is in the background of this image, with the launcher tunnels to the right and the antenna tunnels to the left. The power house, access portal and two large water tanks are behind the photographer

The lift had long gone so it was necessary to walk down 60 feet via the stairs to the bottom of the shaft. Due to the freight lift doors remaining open, this site suffered from a substantial pigeon infestation which made access rather unpleasant.

Having reached the bottom of the shaft, our access was barred to the original sump and lift machinery area by some very nasty looking water. We then exited the entry portal into the main tunnel junction.

ARTIST CONCEPTION  
**TITAN MISSILE COMPLEX**



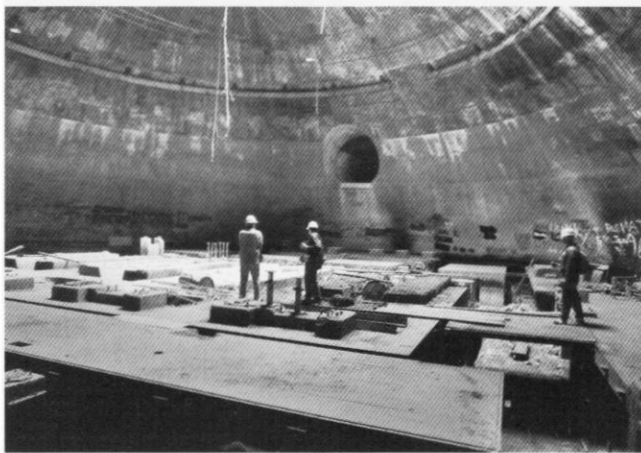
A Martin Marietta drawing of the general layout of a Titan I complex

Our tour began with a quick look around the topside of the site, with specific interest being paid to the three sets of missile silo doors. These are built of steel and concrete with two leaves opened by a single hydraulic ram per leaf.

The main tunnel junction was the main crossroads within the site, linking the power house and launch control centre with the antenna and launcher tunnels. It was obvious that this site had been comprehensively salvaged after closure. All operational cabling and pipe work was gone, along with most of the flooring. Another interesting point in this area was a stream flowing through the site. This was dubbed 'Titan Creek' and was seen to be flowing out of the launcher tunnels and into the power house.

### Power and Pigeons

On exiting the access portal we headed first for the power house, consisting of a reinforced concrete dome 130 ft in diameter and 54 ft high. This originally contained 4x 1250KVA 8-cylinder diesel generators, along with AC equipment and a water treatment plant complete with 2x deep wells. Unfortunately as with the tunnel junction, all the equipment in the power house had been removed – however it was still interesting to view the generator beds and other equipment bases.



The Power House at 568-A. The generator beds are in the centre of the photo while the exhaust shaft is on the rear wall. The whole outer edge of the Power House would have had a steel mezzanine level around it level with the exhaust shaft. This sadly was long gone

From the top level of the power house we then descended down to the underfloor area. It became apparent that the whole concrete floor of the power house was shock-mounted with the structure suspended on hundreds of spring beams permitting lateral, but not vertical, movement. In this area we also discovered the destination of Titan Creek, with water flowing down one of the original deep wells.

Returning to the top level of the power house, we then moved on to the exhaust shaft. This area originally contained large (18-inch diameter) exhaust pipes from the diesel generators, along with the 3x diesel tanks.

All three tanks were still in place, and it was possible to look inside the massive tanks. The two main tanks had a capacity of 67,000 US gallons while the third 'day' tank held 5,000 gallons. Passing the diesel tanks, we entered the exhaust shaft proper.



The exhaust tunnel. The diesel tanks are on the left and right in the middle. The exhaust shaft is visible in the distance

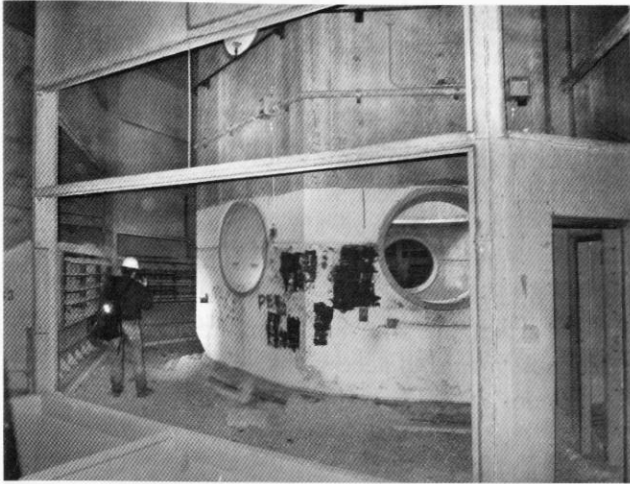
This consists of two concentric concrete shafts. The inner shaft is open to the surface at the top, while the outer shaft contained what remained of the generator exhausts and a/c exhaust fans. The wall between the two shafts contained 12x large pneumatically-operated blast valves (sadly now missing) which would have provided blast protection for the power house. This area of the site was suffering a serious flying rat infestation with all surfaces covered in thick bird waste. The resulting dust and a lack of breathing protection meant that the group did not linger here long.



Looking through the personnel blast door into the exhaust shaft. The holes in the wall would originally have been covered by large blast valve closures

Our next stop was the air intake shaft on the other side of the power house. This was very similar in design to the exhaust shaft, except that it contained banks of cyclonic dust filters to remove particulates from incoming air. These apparently worked rather like a modern Dyson vacuum cleaner, with dust settling in hoppers below.

Interestingly there seemed to be no mechanised method of removing the dust from the hoppers and one can well imagine some poor airman being tasked with shovelling the stuff out. Again this area was full of pigeons so after



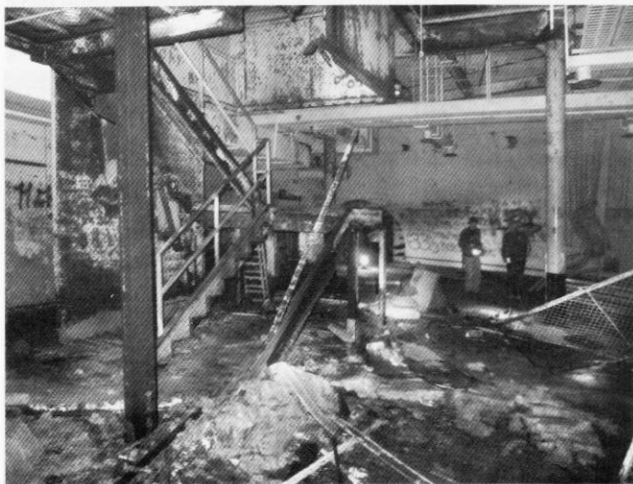
The interior of the air intake shaft. This area shows the location of the blast valves in the wall (now removed). On the left is one of the dust collectors, while in the foreground are the hoppers in which the dust would have been collected

a brief photo session we headed back to the main tunnel junction.

### Out of Control

Our next destination, directly opposite the power house, was the control centre. The control centre was on two levels, and was the area where the crew would have lived while monitoring and operating the site and its missiles. This area originally included comms rooms, air handling rooms, a kitchen/dining room, two 'ready rooms', a 'ready maintenance area' on the ground floor, and 'launch operations' upstairs, from where the rockets would have been monitored and, if required, launched.

As with all other parts of the site yet seen, the control centre had been heavily salvaged, and was suffering from serious water ingress with much corrosion on all metal surfaces. The first area entered was the 'ready maintenance area'. This area would have held spares and equipment used during everyday maintenance of the site and its equipment. The area was a mess, with remaining areas of wire mesh and metal walls resembling the aftermath of some zombie horror film.



The ready maintenance area looking towards the access from the tunnel junction. The remains of the stairs are in the middle

The wall separating the kitchen and ready room areas from the ready maintenance area had been removed, creating a large open area. All original equipment including lights, sockets and a/c vents had been removed, presumably for scrap. Accessing the upstairs area of the control centre was interesting as the first two flights of stairs had been cut away, presumably to deter people like us. Unperturbed by this, a slightly perilous climb was made walking up the edge of the stair frame to the second landing where fortunately normal stair service was resumed.

At the top of the stairs we turned right into what would have been an MDF frame room. This area was empty apart from a large open trapdoor just inside the room complete with a 20-ft drop to the lower level waiting to swallow unwary explorers.



The interior of the MDF room showing the 'hole of doom', the open equipment access hatch to the lower level. The mindless graffiti with which this site was liberally daubed can also be seen

Having inspected the empty MDF room, we moved on to launch operations. This large room was originally filled with equipment including the launch consoles, checkout equipment and the Univac Athena computer which was responsible for guiding the missiles. Unfortunately



Operational shot of Launch Operations. The console for the Univac Athena computer is in the foreground with the launch consoles in the background. (Photograph courtesy of [www.chromehooves.net](http://www.chromehooves.net))

everything in this room including the raised floor had been removed for salvage.

It was however possible to see various underfloor cable trays and a/c ducts along with cut-outs in what remained of the raised floor where equipment would have been mounted.

Having paused for a moment to contemplate the original purpose of this room in the Cold War, we moved on, clambering back down the remains of the stairs to the lower level, and back out to the tunnel junction.

### Guidance in the dark

The next part of the site visited was the 'antenna terminal', accessed by a long and now empty tunnel which originally would have been full of control cabling for the missile guidance system. The guidance system for the Titan I was radio inertial. That is, it made use of an INS-type gyro-based guidance platform with radio correction. The system used a pair of steerable dish antennas which would lock onto a transponder on the missile and provide course correction during the powered phase of flight. A major limitation of the system was that it only permitted the launch of one of the three missiles at a time.

The antenna terminal consisted of two silos which would have contained the antennas, and a tunnel junction, where all the associated electronics were located. The tunnel junction consisted of a large shock-mounted platform still complete with 1960s asbestos chequered floor tiles. All equipment had been removed from the area apart from an overhead a/c unit which remained. Some fun was had in making the shock-mounted floor sway noisily on its springs.

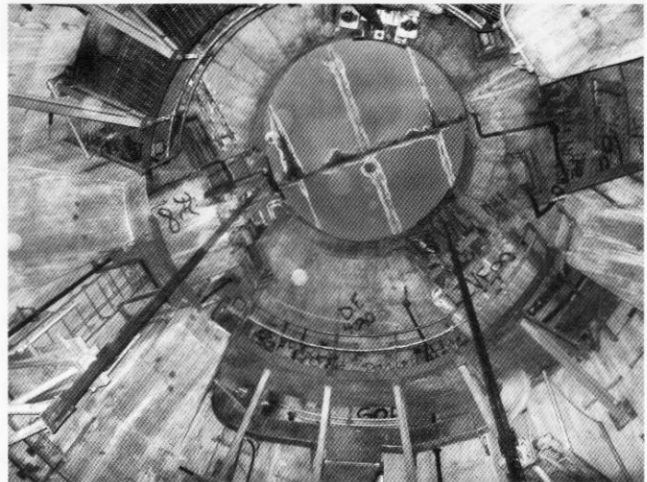


The antenna tunnel junction. One of the antenna silos is visible on the left

At the far end of the tunnel junction were the antenna silos. Each Titan I site had two antenna silos. They are 65 ft deep and 27 ft wide and are separated from the tunnel junction by a large blast door.

The antenna silos at 568-C, as with most other aspects of this part of the site, were largely empty. A large circular hole in the centre of the silo revealed the lower level which was completely full of water. The antenna would

originally have been mounted on a retractable hydraulic platform. This would then have been raised to the surface in order to guide the missiles, but would have normally remained retracted inside the silo for blast protection when not required. The flooded lower level of the silo contained the hydraulic lifting gear, while the upper half contained the antenna on a large shock-mounted platform. Unfortunately the antenna platform had been removed leaving a large empty space. A catwalk surrounded the upper part of the silo; however there was sadly no reasonable means to access this as the original lift had been removed.

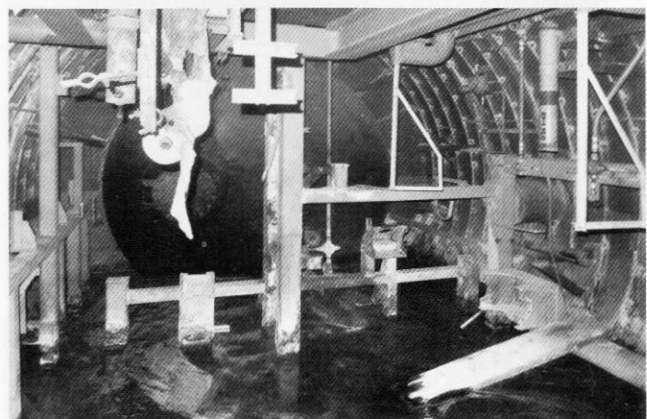


The upper section of an antenna silo. The catwalk level is visible along with the silo doors

Having soaked up the total darkness in the antenna area, we once again headed back to the main tunnel junction.

### RP1

We decided to follow 'Titan Creek' to seek its source, so we headed down the launcher tunnels towards the missile silos. The first area encountered on our journey to the launchers was the 'fuel terminal'. The fuel terminal was the storage tank for the missile fuel (RP1, a form of kerosene). The terminal still contained the 40,000-gallon fuel tank along with a tangled mass of partially salvaged piping. Particular highlights in this area were a shock-mounted air handling unit, and the four nitrogen tanks which would have been used for tank pressurisation and inerting.



The fuel terminal. The RP1 tank is in the background and the nitrogen tanks are out of shot to the left



From the fuel terminal we followed the stream of water further up the tunnels. Earth and stones began to fill the tunnel rising towards the ceiling the further we went. At the top of this bank of earth the source of Titan Creek became apparent in a large breach in the tunnel with daylight showing above. Being 50 feet below ground level it seemed odd to be able to see through to trees outside. The reason for this was revealed later. Having made it as far as possible towards the silos, the lack of headroom coupled with a marked hydrogen sulphide smell meant that a rapid exit from this area towards the tunnel junction was required.

This marked the completion of the 'dry' part of the tour. From here the group headed topside to gain access to the 'wet' part of the site.

### Silo swimming

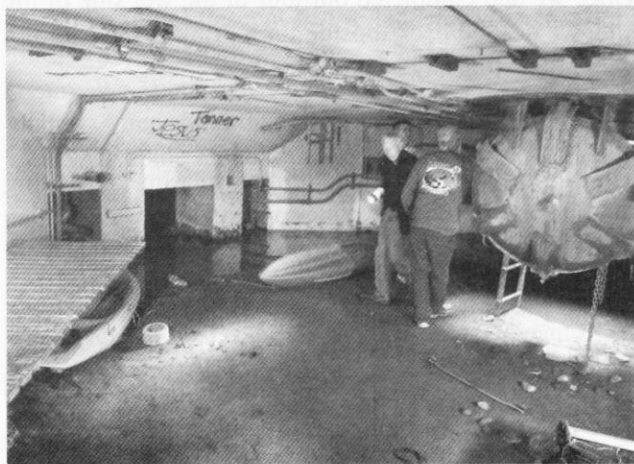


Our entry to the wet side of the site via the remains of an emergency escape shaft

We reached the partially flooded tunnels of the 'launcher area'. Access to this part of the site was via a large excavation which stretched down from ground level and ended at the side wall of the main air-intake structure. Apparently the local farmer who bought the site after decommissioning had the idea of storing potatoes in the power house. A large trench caused the tunnel breach

mentioned above, then the excavation hit the air-intake shaft which seems to have been too much hassle to remove or route around. The resulting hole now provided our access via a former emergency exit shaft.

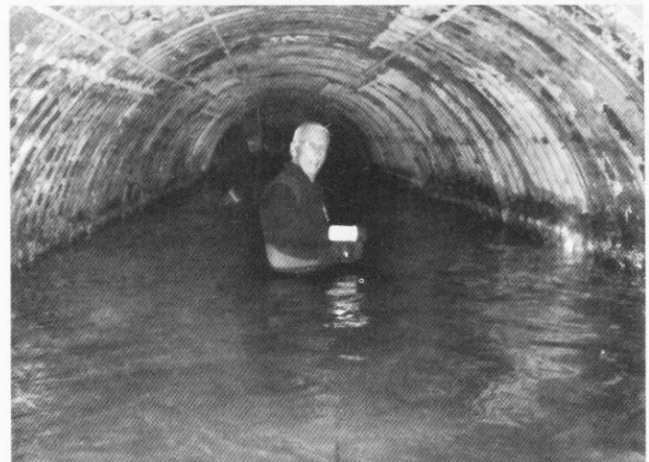
Our hosts, a local diving outfit (3) who dive the silos, provided us with wet suits in order to navigate the partially flooded tunnels and missile silos.



The inside of the muddy blast lock. The blocked tunnel to the main tunnel junction is out of shot behind. Access to Launcher Area 1 is to the left, while launcher areas 2 and 3 are behind the open escape hatch to the right

The first blast lock is effectively a T-Junction with one branch heading back to the main tunnel junction (now blocked); another branch headed to missile silo number 1 via a pair of massive blast doors, and the third branch headed off further towards silos two and three. Our guide informed us that launcher three contained the least flood water, so the group waded into the chilly but very clear waters, and headed off towards Launcher Area 3.

The tunnels had been completely stripped of their original cable trays and most pipe work. Indeed the scrappers had made quite an obstacle course of the place, meaning that getting to the silo took some time due to the removal of large areas of submerged floor, and various types of debris including numerous floating dead mice and discarded pipe insulation.



Starting the wade/swim towards launchers 2 and 3.  
Steve leads the way

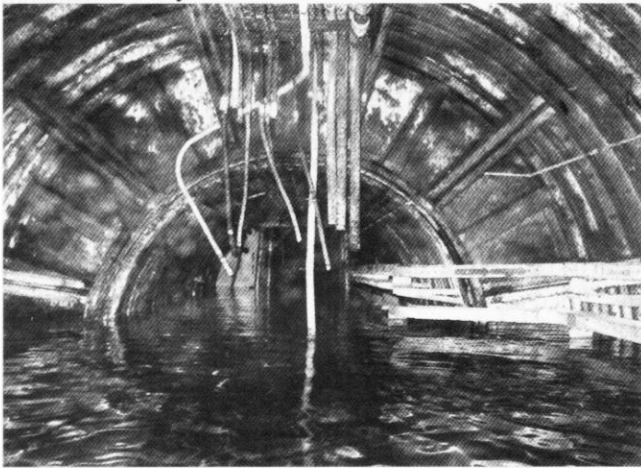


Inside the second blast lock. The blast door leading to Launcher Area 2 is in the centre of shot while that for Launcher Area 3 is out of shot to the right.

The water is about four feet deep

The first part visited on arrival at Launcher Area 3 was the 'propellant terminal'. This area would have held the gas cylinders required to pressurise and service the missile, along with the 28,000-gallon LOX tank. During normal operation the LOX was drained from the missile and stored in the LOX tank, only being loaded immediately prior to launch.

Due to the presence of much stainless steel required for LOX handling, the propellant terminal had been stripped bare with no evidence of any original equipment. The LOX tank had been dug up and removed during salvage, and water now flowed through the welded door to the former tank bay.



Access to the silo 3 equipment terminal. The tunnels appeared to slope downwards in this area, hence the rise in water levels

Our next stop was the 'equipment terminal', a four-storey underground building with two levels now unfortunately under water. Originally the building would have contained hydraulic pumps on the lower level, silo a/c systems on the second level, missile checkout equipment on the third level, and electrical switchgear on the top level. The floors were originally linked with a lift, with ladders for emergency access.

We entered the equipment terminal via the third-level personnel tunnel. The floor was chest-high in water and contained some a/c ducting and cable trays along with the lift shaft. Climbing the ladder to the upper level revealed another empty but dry floor still with original 1960s floor tiles as seen in the antenna terminal. The floor at this level was mounted on spring beams for shock isolation; it was possible to induce some swing in the floor with concerted pushing.

Pushing on, we headed back down the tunnel to the missile silo; this was by far the most impressive site of the entire trip. Sadly the first 100 feet of the structure was flooded, however the upper 60 feet were above water and revealed the silo 'crib work'. The crib was a massive 150-foot-tall steel structure which supported the missile and its lift machinery. The whole structure was suspended from large springs in order to isolate the missile from ground shock. Our guide informed us that 568-C is unique in retaining the crib structure which was usually stripped by the salvagers.

Having taken in the view of the great silo doors above us, a short swim took us to a ladder, enabling us to scale the crib work up to the underside of the silo cap.

The cap contained a concrete walkway with numerous remaining hydraulic lines and cables, along with the lift motor platform.

The motor platform originally carried the large hydraulic motors which would have raised the missile to the surface for firing. It was shock-mounted from a set of four large springs approximately 12 feet tall.

The lift machinery had all been removed, however various pieces of metal debris remained and considerable enjoyment was gained casting these into the water below – the tremendous splash echoed around the inside of the silo for several seconds. Having inspected the concrete 'pillow blocks' which acted as the upper mounts for the crib work, we moved on and headed back towards the blast locks.

Having seen Launcher Area 3, some sections of our group headed topside, while the rest of us headed for launchers 1 and 2. Launcher 2 was found to be flooded above the roof of the access tunnel and thus was not visited. Launcher 1 was very similar to number 3 so I will not describe them in detail here.



Another flooded tunnel shot, in Launcher Area 3. The original framing from the raised floor is visible below the water. The actual tunnel floor was 4-5 feet below the raised floor level

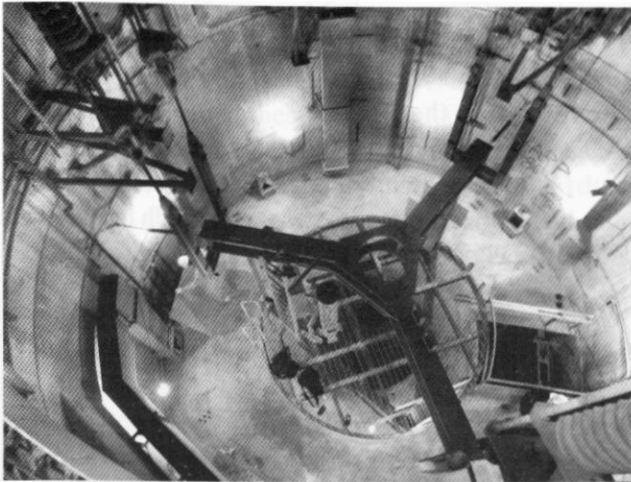
Once we had completed our tour of the wet side of the site, we headed back topside for a drink at the end of a very interesting day of exploring.

### **568-A: Silo climbing**

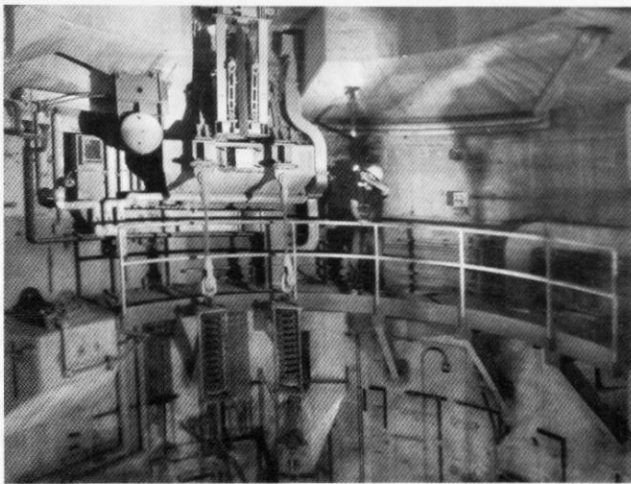
On the following day we visited a second 568<sup>th</sup> SMS Titan 1 site 568-A (4). The primary reason for visiting this site was the complete lack of any flood water which made it possible for us to explore areas which were flooded at 568-C. The general site layout was identical to 568-C and I will therefore only describe the areas which were different and of interest.

The antenna silos were in substantially better condition than those at 568-C and even retained the antenna lift platform.

From the lift platform it was possible to climb up remaining steelwork to the catwalk just below the silo doors.



The shock-mounted antenna platform taken from the catwalk level. This platform would have held the missile guidance antenna and hydraulics used to raise it to the surface.

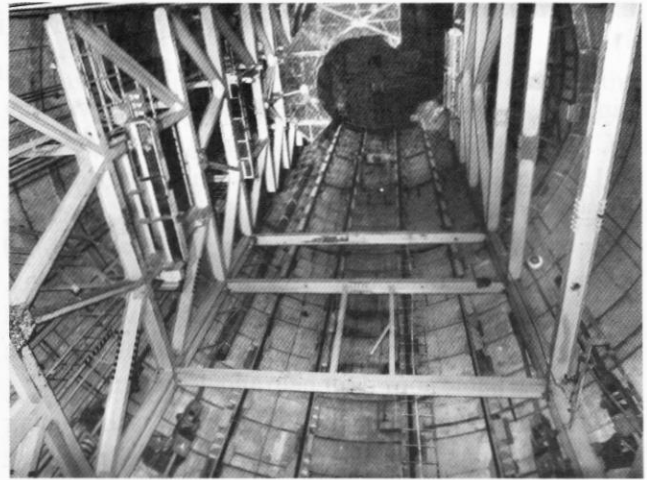


A view from the catwalk level showing the shock suspension system for the antenna platform. Note the concrete mounting block for one of the silo door hydraulic rams on the left

Having inspected the upper level of the silo, we descended to the bottom level. This area was completely flooded in 568-C and it was interesting to see what was located here. An initial descent of the ladder triggered a loud hissing noise which prompted a hasty retreat back up again. We spotted an angry snake hiding in a pile of debris. After some discussion as to who was going to deal with it, the snake was persuaded into a container by one of our party and taken topside. How it had managed to gain entry to the site we'll never know.

Next we headed to the missile silos, two of which still contained some of the silo crib work. The fact that the silos were almost totally devoid of water meant that a silo climb was required in order to see the shock isolation springs, and other features which were hidden by the water at the other site.

Unfortunately the upper 70 feet of crib work had been removed, necessitating an interesting climb via duct and pipework to a set of missile work platforms about 20 feet below our access point.



Looking up the silo from the bottom of the crib work

From there it was possible to climb down a very long ladder to the bottom of the silo which was flooded to just below the bottom of the crib work.

Highlights of this area included the crib shock mounting springs 8x and approximately 20 feet tall, some remaining stainless steel pipework, and of course the view of the silo doors 150 feet above. Unfortunately the launch platform and lift which would have held the Titan I had been removed.

- (1) [www.nv.doe.gov/outreach/tours.aspx](http://www.nv.doe.gov/outreach/tours.aspx)
- (2) [www.titanmissilemuseum.org](http://www.titanmissilemuseum.org)
- (3) [www.underseadventures.net](http://www.underseadventures.net)
- (4) [www.themissilebase.com](http://www.themissilebase.com)

## References

### Books:

- Miller, David. *The Cold War – A Military History*: Pimlico, 2001
- Stumpf, David. *Titan II – A History of a Cold War Missile Program*: University of Arkansas Press, 2000
- Penson, Chuck. **The Titan II Handbook**: Chuck Penson, Tucson, Arizona, 2008
- US Airforce. *HGM-25A Missile Weapon System Technical Manual*: US Airforce, 1964

### Websites

- [www.siloworld.net](http://www.siloworld.net)
- An excellent resource on the early US ICBM program [www.chromehooves.net](http://www.chromehooves.net) The Titan I Epitaph. A very useful information on Titan I history, site construction and present-day site photos
- Thanks go to the site owners for allowing access, but specifically to Pete who runs the Titan I Epitaph for his very interesting website and help in arranging site access, and to Chuck Penson of the Titan Missile Museum for his information and access to the abandoned Titan II sites. Taking part in the trip were Alex Gould, Steve Underwood and Oliver Emberton who all provided photos used in this feature. Additional photos by Pete Essen.

## Latest News from the Wartling Bunker Project, East Sussex

John Smiles

Since the last update on the stabilisation of the Wartling GCI ROTOR bunker in *Subterranea 27* (September 2011) page 33, "Saving Wartling", a steady band of volunteers have put in a further four days' work, investing over 440 man (and woman) hours and another £700 worth of materials and plant on sealing, pumping, cleaning, and fixing. This is a little review of what we've achieved so far, what we've got left to do, rounded off with the almost inevitable appeal for help and donations.

We now have a timetable for 'completion' as the bunker will form part of the itinerary for the Sub Brit Study Weekend in September. By then we plan to have the bunker dry enough to be completely navigable with wellies rather than chest waders, sufficiently waterproofed to be easily maintained at that level, and a whole lot cleaner to try and mitigate some of the damage done by 36 years of neglect, flooding, metal theft and blind vandalism.

I have said before that there is precious little left of Wartling as it's taken such a beating over the years, but I believe that preserving whatever we have left has got to be worth some effort – after all, they're not making any new ones. What's more, working on one of these Cold War giants is a lot of fun if you're into this sort of thing and – as Robin Ware observed recently – you do get an unparalleled insight into the way they were built and operated, just by spending time digging around in them to solve practical problems.

I and a few others, for instance, now know all about the various drains, pipes and fire-mains that thread through the building and out to surface because we have been using them to move water around for pumping. In fact we probably know more about the limitations of their drainage system than the engineers who designed them. Anyway, here's our progress report ...



The main spine corridor on the lower level after removal of an inch of slime. Photo John Smiles

### Pumping Out the Water

Fixed pipe runs are now in place for emptying the bunker and for ferrying water between the levels. We have discovered that the pump rates don't match between the floors as one has to overcome more height, so we need to pump the top level much more than the bottom one. Adjusting the rates with timer switches, we have balanced the flow and can only really move half the water either one of our two big pumps can achieve if working at optimum capacity. Nonetheless, we reduced the water level downstairs by just over a foot overall (20 percent of target) over one weekend where we pumped intermittently for 27 hours.

These rates means we can easily empty the bunker before September, either by pumping for a week with local volunteers looking in to check nothing is running dry (please let me know if you can help), or by doing it over a few more weekends.

We also discovered that the surface soakaway installed in the Fifties isn't really all that good. If we run our pump at full bore (just over 500 litres a minute) then we can only run for about an hour before the ground is inundated, the pump backs up and slows dramatically. Quite why this happens was demonstrated by Bob Clary, David Heyes and Dom Jackson one evening when they started poking a wet bit of the field above with a digging spike and managed to make several new springs. We've since made a back-up route to pump to the surface.

### Waterproofing

All our water dams are now fully tanked and a new catch dam has been installed to divert any water coming down the stairs into the Grey Water Tank (GWT) and thence into the Sewage Ejector Pit (SEP) where our main

surfacing pump sits. Everything is holding / watertight except the repairs we made to the cableways in the Emergency Exit building – which we saw streaming with water during an educational downpour during the last workday. These will be resealed with concrete and tanking on the next visit.

We have also fitted manual bilge pumps that allow us to quickly and easily drain any water the catch dams do intercept.

### Power and Light

A new, safer, power supply and lighting circuits have been fitted in as subtle and sympathetic a

way as possible. Power and lights extend down the top corridor. We have also stripped out a large amount of temporary lighting and circuits that were strewn around at various points and then abandoned as they failed in the damp. Our new installation uses armoured cable throughout for power and is all outdoor-rated to resist the damp. It should be a permanent fix.



Dom and Mike and Bob connecting up new power and lights. Photo Ed Combes

Next time we plan to improve the connection to the outside world, extend the lights right down the top corridor to the main staircase, and fix one last socket to give us a flexible power supply that can reach all the dry bits of the bunker with a decent extension lead.

### Clean-up

The last work weekend saw the first real clean-up operations we have had a go at. This made quite a change from the heavier work we have been doing on earlier visits and everyone could get stuck into the same area at once which was fun.

All the clay and debris has been cleared from under the stairs of the Emergency Exit building. Most of the rooms that still have floors on the left of the top corridor have been cleared of debris and washed out. The wet debris piles are being sprayed down with PVA adhesive to fix any dust. The bottom corridor was also swilled off (see picture) and dried with some of the big floor squeegees we use to such good effect at Paddock.

Amazingly, the airflow we introduced by building the vent stack at the top of the previously sealed old cableway at the far end of the bunker has made a huge difference

to air quality and the bottom corridor now dries out between visits.

We have also amassed a huge pile of rotting wood at the foot of the main stairs. Every single future visitor is likely to be asked to help carry out a few sticks of this.

Sadly the vent stack we built over the sealed cableway – while working quite well – has subsided under its own weight and the attentions of the farmer’s cows who think it makes an excellent scratching post. It is now leaning at a jaunty angle. We have decided to wait and see with this one, and we will winch it back into an upright position and recast the base once we are sure it has stopped moving.

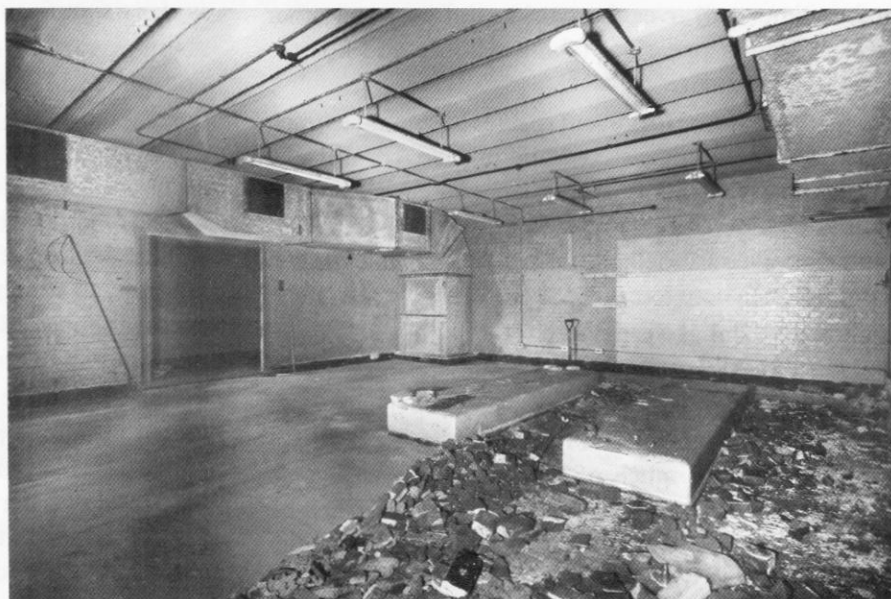
### What’s next?

Overall we have made a massive difference to the state of preservation of the Wartling bunker and we plan to carry on going while the enthusiasm is still there.

If you are joining the Sub Brit Study Weekend in September you will be able to see the progress for yourself and learn something of the bunker’s history and place in the ROTOR system. If you can’t attend, don’t worry – regular future visits are assured thanks to our relationship with the farmer and his family who are delighted with the efforts we have put in (evidenced by regular deliveries of cake when we are on site).

We have at least two more work weekends planned before September and pretty much anyone is welcome to join in provided you don’t mind getting your hands dirty; just contact me through the website.

We continue to burn through our limited funds at a steady, though thankfully diminishing, rate. If you can spare a few quid to help pull Wartling partially out of its dilapidation and secure it for the future, please do chip in. You will find a donations link on the Sub Brit homepage or, again, just drop me a line. Thanks in advance.



Half way through clearing out over a ton of debris in the GPO power room on the upper floor. Photo John Smiles

## Deep Underground in West Sussex and Norway

### Kew's Millennium Seed Bank and Svalbard's Global Seed Vault

Stewart Wild

Plant biodiversity is important, very important. All the world's major food crops originated in tropical and subtropical regions of our increasingly overcrowded and overdeveloped world. It's over 120,000 years since hunter-gatherers began collecting and sowing plant seeds and learning how to benefit from their harvest. Biodiversity refers to the evolved traits that crops have developed over millennia to survive and adapt to continually changing environments.

Genebanks are modern scientific institutions for the collecting, cataloguing and storage of plant diversity, and for research leading to the improvement of agricultural crops. There are around 1,400 genebanks, or "crop diversity collections", in more than one hundred countries around the world and they house more than six million seed samples, some of which have become extinct and now exist only in genebank collections.

Many people are aware of the UK's Millennium Seed Bank, located at Kew Gardens' outpost at Wakehurst Place, near Ardingly in West Sussex. Fewer have heard of a similar project in Norway, in the remote northern archipelago of Svalbard (aka Spitsbergen).

#### **Kew's Millennium Seed Bank**

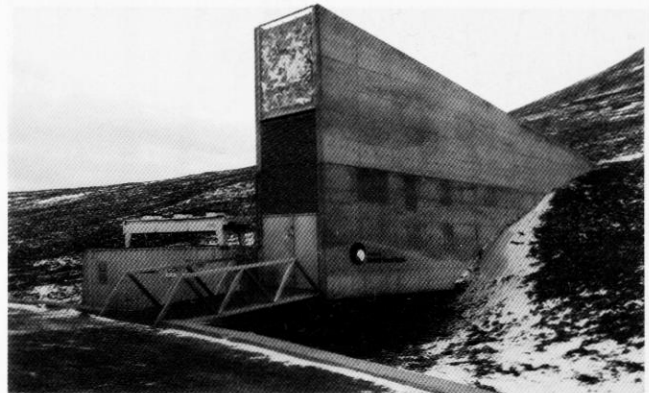
Based at Wakehurst Place, Kew's genebank is the largest conservation project of its kind in the world. Over two billion seeds are stored at  $-20^{\circ}\text{C}$  in a deep underground bomb-proof vault. Already Kew's scientists have managed to store seeds and plant specimens from ten percent of the world's wild plant varieties, with more than 40,000 species now safely in the bank.

The botanists' target is to store 25 percent of the world's plants by 2020 – about 100,000 species. But it's a race against time – all over the world rainforest and other habitats are disappearing, taking wildlife and botanic diversity with them.

The seeds are stored to prevent species becoming extinct. The world has become dependent on rice, corn, wheat and hundreds of other types of plant and grain as prime sources of food. It is not just foodstuff plants that are important; scientists believe that plants are being lost that could hold the cure to cancer and other diseases.

#### **Svalbard's Global Seed Vault**

At  $78^{\circ} 13'$  north,  $15^{\circ} 33'$  east, Longyearbyen's vault is only 810 miles from the North Pole. The advantage of building an underground storage facility this far north, of course, is that for much of the year Longyearbyen's average temperature is well below zero. Even during the short summers, the ground remains frozen except on the surface. Unlike at Wakefield Place, little energy is needed to keep the contents of the vault frozen.



Entrance to the Svalbard vault. Photo Sarah Wild

Svalbard's vault, inaugurated in 2008, is capable of storing billions of crop seeds; it is administered by the Global Crop Diversity Trust and managed by Norwegian government agency Statsbygg. The vault has been designed to protect against natural and human disasters, including global warming, floods and fires and nuclear holocaust – Svalbard was chosen for its remoteness, sound geology and, as mentioned, the ambient temperature of the permafrost.

#### **International Cooperation**

The construction of the vault, which cost the equivalent of around £5 million, was funded entirely by the Norwegian government. Operational costs, however, are met by Norway and the Diversity Trust, which is itself funded by the UK, Norway, Australia, Switzerland and Sweden, plus a number of other countries including Brazil, Ethiopia and India. The Bill and Melinda Gates Foundation is also a significant contributor.

A huge variety of plant seeds are held in a deep underground cavern. After rigorous quarantine, cleaning, drying and packaging procedures, they are transferred to a vast cold store at a temperature of  $-18^{\circ}\text{C}$ . All the seeds are duplicate samples, or "spare copies", of seeds held in other genebanks worldwide, providing insurance against the loss of seeds elsewhere on account of some kind of catastrophe or future crisis. Ownership of and access to the seeds remains with the foreign genebank that deposits them.

Svalbard's remote and very secure genebank is a sort of global insurance policy, for many of the world's seed collections face challenges in funding as well as threats of natural disaster and civil strife. Out of sight but not forgotten, the contents of Svalbard's deep underground vault might one day prove to be the most important insurance in the world.

## Discounted Cotswold Shopping

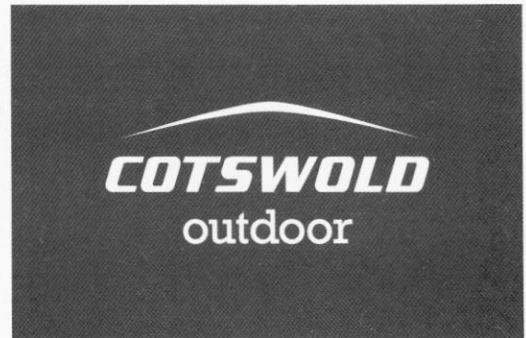
Cotswold Outdoor have granted Sub Brit members a 15% discount on their products (excluding sales and special offers). The details are included in a letter on the website at

[www.subbrit.org.uk/docs/discount-cotswold-outdoor.pdf](http://www.subbrit.org.uk/docs/discount-cotswold-outdoor.pdf)

If you are not able to access the website, then please contact us with an SAE for a copy of the letter.

The discount code can be used in any of their 58 stores (there is a barcode on the letter), and for telephone and online orders.

*\*\*\* Please do not share or abuse the code as this may lead Cotswold to withdraw it which would be a great shame and spoil things for the rest of our members. \*\*\**



Here is an introduction from David Hague of Cotswold:

“Cotswold Outdoor are proud to be a supporter of such a prestigious organisation as Sub Brit. As most of your members are aware, Cotswold Outdoor is a multi-award winning retailer with numerous thriving stores located nationwide. Not only are we proud of our knowledgeable staff, but our stores stock one of the most comprehensive ranges of outdoor clothing and equipment in the UK. With a huge range of footwear, waterproof jackets and fleeces, tents, sleeping bags and outdoor accessories, we offer one of the best selections of clothing and equipment right on your doorstep.

Whoever you are and whatever you need, when you shop with us you can be assured of expert, award-winning service and advice that comes from 40 years of experience in retailing. We’re really looking forward to welcoming you to our store, online or over the phone soon. I hope that our discount helps your members purchase the right kit and equipment as they continue with their important and valued pastime. We are passionate about giving the right advice and recommending the right clothing and equipment so you can have peace of mind while out in (or should that be under!) the field.”

### **Kelvedon Hatch Social Meeting - Sunday 15 July 2012**

**(See flyer included in *Subterranea*)**

Kelvedon Hatch Bunker near Brentwood in Essex was originally an RAF ROTOR station, then an RGHQ. The aim of this meeting is for both new and established members of Sub Brit to get know each other whilst they explore the bunker in small groups, perhaps with a view to understanding how it would have performed during the various roles of its operational life. With this in mind, you can view the interior structure to see how it was adapted over the years for change of use and see the BBC studio. Viewing the exterior, you can see how electrical supply and communications were provided for, together with sewage disposal and the original discrete entrance.

For those who wish to practice and/or develop their photographic skills, photography for private research is permitted. This excludes publication of any photographs and or imagery unless previously authorised by the site owner. The cost is £6.50, directly payable on the day.

To register your interest, please send your contact details and whether you would be likely to purchase a meal on site to [bob.templeman@btinternet.com](mailto:bob.templeman@btinternet.com).

